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Geology of
Carbonatite – Alkalic Rock Complex In Ontario:
Seabrook Lake Carbonatite Complex
District of Algoma

Ontario Geological Survey
Study 31

by R. P. Sage

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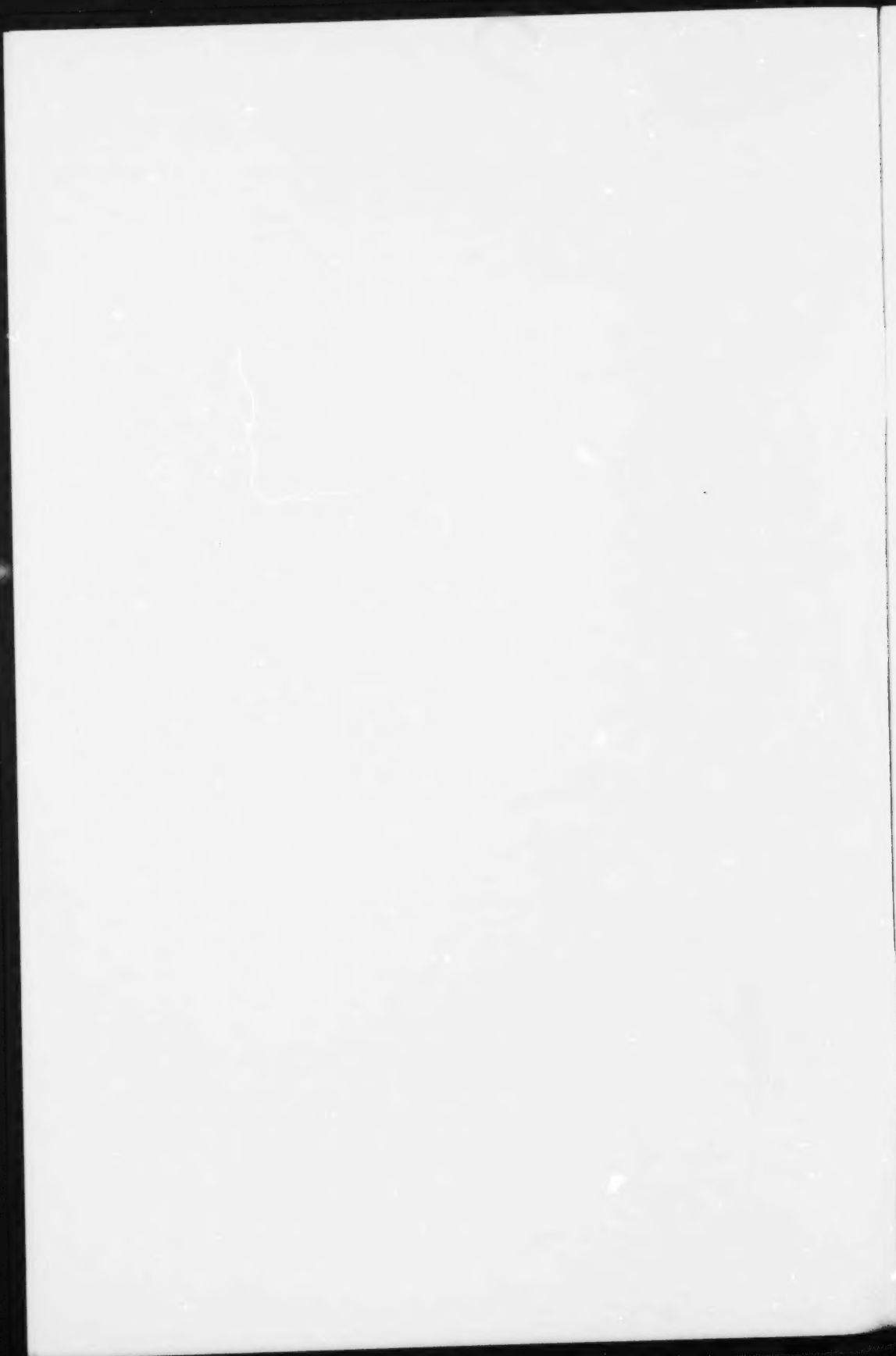
Foreword

The Seabrook Lake Carbonatite Complex was examined as part of a project to study alkalic rock – carbonatite complexes in Ontario. The study describes the rock types and mineralogy of the complex and outlines the history of the mineral exploration efforts within the complex.

V.G. Milne

Director

Ontario Geological Survey



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CHART (back pocket)

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CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

Conversion from SI to Imperial

Conversion from Imperial to SI

SI Unit Multiplied by Gives Imperial Unit Multiplied by Gives

LENGTH

1 mm	0.039 37	inches	1 inch	25.4	mm
1 cm	0.393 70	inches	1 inch	2.54	cm
1 m	3.280 84	feet	1 foot	0.304 8	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	1.609 344	km

AREA

1 cm ²	0.155 0	square inches	1 square inch	6.451 6	cm ²
1 m ²	10.763 9	square feet	1 square foot	0.092 903 04	m ²
1 km ²	0.386 10	square miles	1 square mile	2.589 988	km ²
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha

VOLUME

1 cm ³	0.061 02	cubic inches	1 cubic inch	16.387 064	cm ³
1 m ³	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m ³
1 m ³	1.308 0	cubic yards	1 cubic yard	0.764 555	m ³

CAPACITY

1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	4.546 090	L

MASS

1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	31.103 476 8	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	0.453 592 37	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	907.184 74	kg
1 t	1.102 311	tons (short)	1 ton (short)	0.907 184 74	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	1016.046 908 8	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	1.016 046 908 8	t

CONCENTRATION

1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in cooperation with the Coal Association of Canada.



**Geology of
Carbonatite – Alkalic Rock Complexes in Ontario:
Seabrook Lake Carbonatite Complex
District of Algoma**

R.P. Sage¹

1. Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto. Manuscript approved for publication by John Wood, Chief Geologist, Ontario Geological Survey, October 19, 1983.

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Abstract

The Seabrook Lake Carbonatite Complex is located in the Abitibi Subprovince of the Superior Province of the Canadian Shield. The intrusion occurs at the intersection of several regional linears and perhaps represents the southern limit of alkalic magmatism associated with faulting in the Kapuskasing Structural Zone that lies immediately to the north.

The complex is composed of ijolite, sovite and silicocarbonatite and is enveloped in fenitized breccia. The complex has been dated by K-Ar isotopic techniques at 1109 and 1107 Ma.

The intrusion is known to host niobium mineralization but insufficient work has been completed to fully evaluate its niobium potential. Minor apatite mineralization is present.

Résumé

Le complexe de carbonatite du lac Seabrook est situé dans la sous-province Abitibi, dans la province Supérieure du bouclier canadien. L'intrusion est située à l'intersection de plusieurs linéaires régionales et pourrait être la limite sud du magmatisme alcalin associé aux failles de la zone structurale de Kapuskasing située tout juste au nord.

Le complexe est formé d'ijolite, de sovite et de silicocarbonatite et est enveloppé de brèche fénitisée. D'après les techniques isotopiques de datation au K-Ar, l'âge du complexe serait de 1109 ou de 1107 Ma.

On sait que l'intrusion comprend une minéralisation de niobium mais on ne peut en déterminer précisément la teneur. On a également relevé la présence d'une minéralisation d'apatite.

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Introduction

The Seabrook Lake Carbonatite Complex was briefly examined as part of a province-wide evaluation of the alkalic rock – carbonatite complexes of Ontario. The complex lies within the Abitibi Subprovince of the Superior Province and Gittins *et al.* (1967) reported K–Ar isotopic ages of 1109 and 1107 Ma for the complex. The complex is tadpole-shaped in plan view, tapering to the south, and occupies an area of approximately 1.5 km².

The bulbous northern portion consists dominantly of sovite and silicocarbonatite and the elongate tapering mass to the south consists dominantly of rocks of the ijolite suite.

The carbonatite and ijolite are enclosed within an envelope of fenitized granitic rocks which grade into unfenitized granite. The granitic rocks are Early Precambrian in age and have been cut by a northwest-trending set of diabase dikes.

Within the last 30 years the complex has undergone prospecting activity which has disclosed the presence of niobium and minor apatite mineralization.

Acknowledgements

The author was assisted in mapping by Mr. Carl Higgins and Mr. Paul Chamois, geological assistants. Previous mapping by Parsons (1961) served as the basis for the present project. Mr. A. Lisowyk revised the tables in the appendix and recalculated the statistics on rock chemistry in 1988.

Location and Access

The Seabrook Lake Carbonatite Complex is located in Maeck and Rollins Townships at approximately 47°00'00"N Latitude and 83°17'00"W Longitude (Figure 1). The complex is partially covered by the waters of Seabrook Lake and is elongated in a north–south direction. Its general configuration is roughly outlined by aeromagnetic maps 2228G and 2229G (ODM–GSC 1963a,b).

Seabrook Lake can be reached by a forest access road running west from Highway 129 near Aubrey Falls to Tidy Bay on the east shore of Seabrook Lake. From Seabrook Lake the interior portions of the complex can be easily reached by short traverses. The surface of the complex forms a slight topographic high with respect to the surrounding area which is underlain by fenitized granite breccia. Several steep-sided gulleys cross the complex.

Field Methods

The base map for the present project was Map 2005 (Parsons 1961). Mapping was done on acetate overlays of 1:15 840 airphotos supplied by the Airphoto Library of the Ontario Ministry of Natural Resources.

Previous mapping by Gunnex Limited and the International Minerals and Chemical Corporation was of assistance in the present project. The work by the author and exploration companies has resulted in minor local alterations to some contacts previously indicated by Parsons (1961). The author has retained Parsons' (1961) classification of the rocks.

Previous Geologic Work

Parsons (1961) completed a report on the complex for the Ontario Department of Mines and Osatenko (1967) completed an MSc thesis at the University of

CARBONATITE - ALKALIC ROCK COMPLEXES: SEABROOK LAKE



Figure 1. Key map showing location of carbonatite - alkalic rock complexes in Ontario.

- | | | |
|--------------------|------------------------|---------------------------------|
| 1. Eastview | 17. Clay-Howells | 32. Prairie L. |
| 2. Brent | 18. Hecla-Kilmer | 33. Port Coldwell |
| 3. Callander B. | 19. Valentine Tp. | 34. Herman L. |
| 4. Manitou Is. | 20. Goldray | 35. Firesand R. |
| 5. Burritt Is. | 21. Argor | 36. Slate Is. |
| 6. Iron Is. | 22. Lawashi R. | 37. Poohbah L. |
| 7. Lavergne | 23. Poplar R. | 38. Sturgeon Narrows & Squaw L. |
| 8. Spanish R. | 24. Albany Forks | 39. Schryburt L. |
| 9. Otto Stock | 25. L. Drowning R. | 40. Big Beaver House |
| 10. Seabrook L. | 26. Kingfisher R. West | 41. Wapikopa L. |
| 11. Lackner L. | 27. Kingfisher R. East | 42. "Carb" L. |
| 12. Borden Tp. | 28. Martison L. | 43. Gooseberry Br. |
| 13. Nemegosenda L. | 29. Nagagami R. | 44. Niskibi L. |
| 14. Shenango Tp. | 30. Chipman L. (dikes) | 45. Nemag L. & Lusk L. |
| 15. Cargill Tp. | 31. Killala L. | |
| 16. Teetzel Tp. | | |

British Columbia. As part of Operation Chapleau, a regional reconnaissance survey, the author prepared a brief description of the complex (Thurston *et al.* 1977).

Cullers *et al.* (1973) have published some data on rare earth element distribution within the intrusion. Cullers and Medaris (1977) have proposed a model for the genesis of the Seabrook Lake Carbonatite Complex on the basis of rare earth element distribution coefficients. Mitchell (1972) studied the pyroxene, biotite and nepheline compositions of the ijolite phase of the complex.

An MSc thesis on the petrogenesis of the Seabrook Lake complex was completed by Parbery (1984).

Physiography

Topographic relief on the complex is on the order of 30 m and in the immediately surrounding terrain from 75 to 90 m. The complex is traversed by gulleys and the bush is thick and dense. Outcrops are small and widely spaced on the north end of the complex and relatively abundant on the south end of the complex.

Laboratory Techniques

A select group of rocks of the ijolitic suite were submitted for whole rock analysis. The samples were selected on the basis of their freshness and homogeneity.

The carbonatitic rocks are commonly too heterogeneous to be considered for whole rock analysis. A select group of samples were thin sectioned for petrographic examinations. The petrographic descriptions and chemical analyses are given in Appendix A.

Nomenclature

The various lithologic units of the complex were originally classified and named by Parsons (1961).

The author has used a somewhat different nomenclature in describing the Seabrook Lake Carbonatite Complex. For the alkalic rocks the author prefers to use mineralogical, colour, or textural modifiers which are familiar to all readers rather than unfamiliar rock names. Alkalic rock nomenclature is cumbersome, due in large part to the profusion of rock names, consequently as an aid to the reader the use of less familiar rock names will be avoided. Those rock terms retained by the author and how they are used are given below.

Ijolite. A nepheline-pyroxene rock with a nepheline content between 30 and 70%. Rocks containing more than 70% nepheline are classified as urtite and those with less than 30% as melteigite. Some specimens may contain significant amounts of biotite in preference to pyroxene. Potassium feldspar is 10% or less and those samples with 10% or less nepheline are classified as pyroxenite.

Malignite. This rock term refers to a melanocratic nepheline syenite. In general nepheline, pyroxene and potassium feldspar occur in roughly equal proportions. The potassium feldspar content must exceed 10% or the rock is classified as belonging to the ijolite suite. Both the nepheline and pyroxene content must exceed 10% or the rock would be classified with the syenites. This rock group is transitional between the ijolites and overlaps the syenites.

Sovite. An igneous carbonate rock consisting of 50% or more calcite. Various mineralogic modifiers are used to classify the sovite.

Silicocarbonatite. An igneous carbonate-rich rock composed of 50% or more oxide and silicate minerals. Where the silicate mineralogy exceeds 90% various other rock names are applied, i.e. ijolite, biotite, pyroxenite, etc.

Syenite. This term is restricted to a quartz-free rock consisting of alkali feldspars. Various mafic minerals and nepheline may be present and form a significant component of the rock. The syenites are named on the basis of their mineralogy, i.e. pyroxene nepheline syenite, biotite nepheline syenite, biotite amphibole syenite, etc. The syenites are gradational into malignites.

The subdivision of the ijolite suite into ijolite, urtite and melteigite has no standard subdivision. Bailey (1974) classified urtite as a rock containing more than 70% nepheline, however he uses the term ijolite to apply only to those rocks containing between 50 and 70% nepheline. The author finds this range to be too restricted for field work and prefers the 30 to 70% range given by Williams *et al.* (1954, p.70).

Malignite was originally defined by Lawson (1896) as an alkali-lime rich syenite rock composed of pyroxene and potassium feldspar with or without nepheline, amphibole or garnet, from the Poohbah Lake Alkalic Rock Complex in northwestern Ontario. The author has examined this complex and a large number of thin sections of the malignite. The malignites are melanocratic and contain nepheline, orthoclase, garnet, and nepheline. The nepheline content of the type location is relatively low when compared to the definition given above. To better emphasize the gradational nature of the malignites into ijolites and syenites without the use of cumbersome terminology, a broader usage of the term is applied by the author. Williams *et al.* (1954, p.65-66) described a number of malignites of varying mineralogy.

The definitions of sovite and silicocarbonatite are modified from Heinrich (1966, p.12). The author has found Heinrich's subdivision of the carbonate-rich carbonatite rocks generally suitable for field mapping if modified to a two-fold subdivision at about 50% oxide and silicate mineral content. The two-fold subdivision is more convenient than the four-fold subdivision of Heinrich (1966) because carbonatites are extremely variable in mineral content over distances of less than a few centimetres. It is difficult to rigorously classify such heterogeneous rocks.

General Geology

The Seabrook Lake Carbonatite Complex lies within the Abitibi Subprovince of the Superior Province of the Canadian Shield. Gittins *et al.* (1967) reported K-Ar isotopic ages from biotite of 1109 and 1107 Ma for the complex. The general shape of the complex is illustrated on the aeromagnetic map (Figure 2). Table 1 lists the lithologic units for the complex.

The complex consists predominantly of two rock types: carbonatite and ijolite. The carbonatite rocks are found in the northern portion of the complex, are highly variable in mineral content and texture, and are locally rich in hematite. Carbonate and biotite are the dominant minerals but pyroxene may locally be present in major quantities.

Extending southward from the carbonatite rocks is an elongated body of ijolite, composed principally of nepheline and pyroxene. This rock unit is highly variable in composition changing from pyroxenite (less than 10% nepheline) to pegmatitic segregations of urtite (greater than 70% nepheline). The rock is black

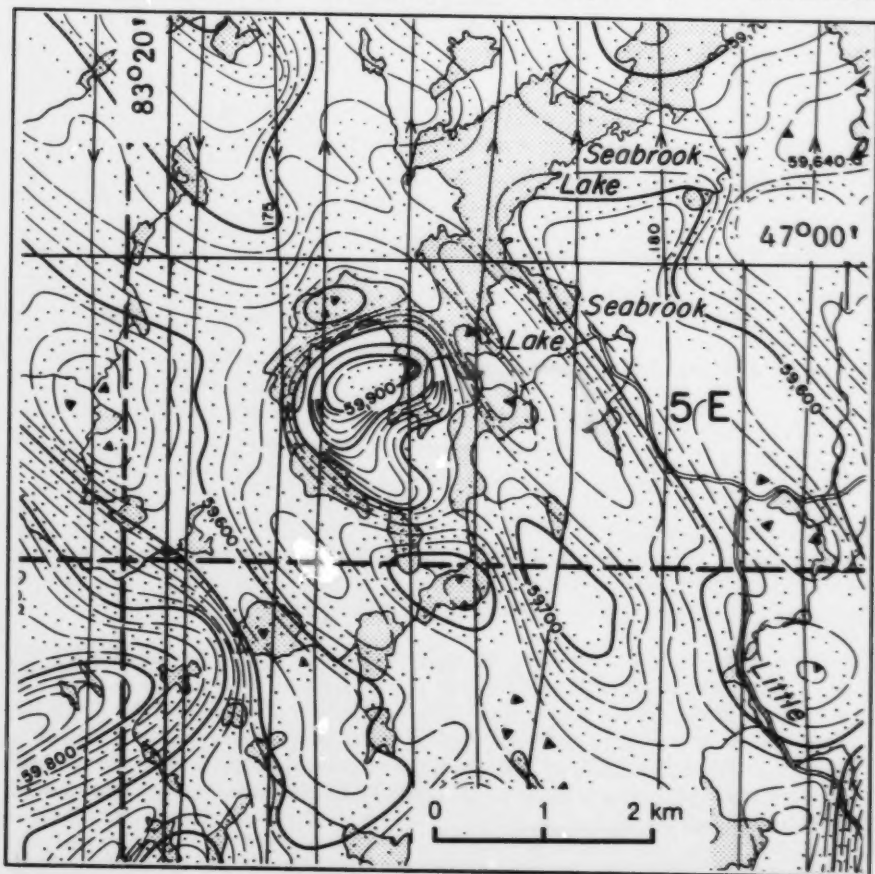


Figure 2. Aeromagnetic map of the Seabrook Lake Carbonatite Complex (from Maps 2228G and 2229G, ODM-GSC 1963).

CARBONATITE - ALKALIC ROCK COMPLEXES: SEABROOK LAKE

TABLE 1. TABLE OF LITHOLOGIC UNITS FOR THE SEABROOK LAKE CARBONATITE COMPLEX.

CENOZOIC

Recent

Swamp and stream deposits.

Pleistocene

Glacial drift, gravel, sand, and silt.

Unconformity

LATE PRECAMBRIAN (PROTEROZOIC)

Seabrook Lake Carbonatite Complex

Dike Rocks

Mafic alkaline dike rocks; biotite-calcite rocks.

Intrusive Contact

Carbonatite Rocks

Sovite; sovite dikes; hematite sovite.

Silicocarbonatite, locally brecciated.

Intrusive Contact

Ijolite Rocks

Ijolite; biotite ijolite; malignite.

Intrusive Contact

Fenites

Fenitized granite breccia; fenitized granite.

Intrusive Contact

MIDDLE PRECAMBRIAN (PROTEROZOIC)

Diabase Dikes

Diabase.

Intrusive Contact

EARLY PRECAMBRIAN (ARCHEAN)

Granitic Rocks

Granodiorite to quartz monzonite.

to dark green in the pyroxene-rich phases to pale pink in the urtite phases. The unit is massive, medium to coarse grained, equigranular. In thin section most samples that were originally mapped in the field as pyroxenite contain sufficient nepheline to be classed as ijolite (between 30 and 70% nepheline). One sample contains sufficient potassium feldspar to be classed as malignite.

Enveloping the carbonatite and ijolite rocks is a zone of fenitized granite breccia. This unit consists of pink to red-brown clasts of altered granitic rock in a fine-grained dark matrix of altered and comminuted rock. Outward from the altered breccia is a zone of fenitized granite which may approach 300 m in width. Farther away from the complex the granite becomes increasingly less altered and fenitized. The granite is typical of the late Early Precambrian granite diapirs found throughout the Canadian Shield.

The granitic rocks, but not the carbonatite complex, are cut by a set of north-west-striking diabase dikes. Small dikes of carbonate-rich rock and lamprophyre cut the granitic rocks in several places.

The spatial arrangement of the various lithologic units is illustrated on the geological map (Figure 3, Chart A, back pocket).

EARLY PRECAMBRIAN (ARCHEAN)

GRANITIC ROCKS

The Seabrook Lake Carbonatite Complex is enveloped in massive, medium- to coarse-grained, red to red-brown, leucocratic, granodiorite to quartz monzonite (Unit 1). Rarely, the granitic rock contains pegmatitic and aplitic segregations. The granitic rock is well exposed and forms rounded ridges and hills surrounding the Seabrook Lake Carbonatite Complex. Samples for petrographic examination were all collected within 0.8 km of the carbonatite complex.

In thin section, the unaltered granite is leucocratic, massive, coarse grained, equigranular, and hypidiomorphic. The mode is estimated to be 30–35% quartz, 40–50% plagioclase of oligoclase to andesine composition, trace to 25% potassium feldspar, and up to 5% altered biotite. The quartz has undulatory extinction and commonly displays incipient fenitization indicated by the presence of acicular sodic amphiboles along fractures and grain boundaries. The plagioclase invariably is turbid due to finely disseminated sericite(?) and possibly kaolinite alteration. The plagioclase is euhedral to subhedral in form and some grains are fractured and/or display bent albite twin planes. Some sections have a clear, protoclastic texture.

Potassium feldspar consists of perthitic microcline and microcline perthite. The potassium feldspar is anhedral in form, interstitial to the plagioclase and fresh in appearance. Larger grains of potassium feldspar may poikilitically contain anhedral to subhedral grains of turbid plagioclase in a random orientation.

Minor biotite is present and commonly has extensively altered to limonite and chlorite. The biotite is interstitial to the feldspars and quartz, often turbid; locally it appears to have been replaced by a very fine-grained, acicular amphibole along the edges of the grains.

The presence of acicular sodic amphibole along fractures and grain boundaries in what appears to be fresh rock in the field, suggests that completely unaltered rock was not encountered and that weak fenitization is widespread.

Parbery (1984, p.23) classified the granitic rocks as quartz monzonite and described them as consisting of saussuritized albitic plagioclase, turbid microcline, and chloritized biotite. Traces of sphene, hematite, fluorite and apatite were reported.

Parbery (1984, p.38, 133) determined that the potassium feldspar composition is Or₉₂ to Or₉₉ and the plagioclase composition is Ab₈₈ to Ab₉₉.

MIDDLE PRECAMBRIAN (PROTEROZOIC)

DIABASE

The granitic rocks are cut by a set of northwest-trending diabase dikes (Unit 2). The dikes are fine to medium grained, and have green-grey weathered surfaces and black to dark green fresh surfaces. The dominant trend of the dikes is northwest but Parsons (1961) reported one or two exceptions to this trend. Some dikes were reported by Parsons (1961) to be characterized by scattered to fairly thickly packed, large phenocrysts of light-green plagioclase. On the basis of the appear-

ance of the porphyritic diabase dike Parsons (1961) classified the dikes as Matachewan in age.

Parsons (1961) reported that the dikes are cut by carbonate veins or carbonate-mafic silicate zones. Neither the author nor Parsons (1961) observed diabase dikes cutting the carbonatite complex. The author did not prepare thin sections from samples of the diabase dikes.

LATE PRECAMBRIAN (PROTEROZOIC)

SEABROOK LAKE CARBONATITE COMPLEX

Fenites

Fenitized Granitic Rocks

Rocks of Unit 3 are identical to the granitic rocks previously described but display visual evidence of fenitization and alteration on the weathered outcrop surface. The joint surfaces are coated with bluish green to dark green sodic amphiboles. On the basis of sketchy optical data the author has previously suggested that the amphibole was arfvedsonite (Thurston *et al.* 1977). More detailed X-ray diffraction studies by Osatenko (1967) indicate that it is a magnesio-riebeckite with a rim cap of riebeckite. The use of X-ray diffraction techniques for amphibole identification is unreliable and more detailed optical and/or microprobe studies are needed. In close association with the sodic amphiboles that are present along the fractures and joints is a rusty brown, weathering carbonate, perhaps ankerite or ferruginous dolomite. Osatenko (1967) reported the presence of aegerine, sodic plagioclase, and pyrochlore in the fenitized rocks.

The altered granites are commonly much deeper red in colour than the fresh rocks. The colouration appears to be due to a very fine-grained dusting of hematite. With increasing intensity of fenitization the quartz grains of the granite have been selectively replaced, ultimately the granitic rocks have been transformed into a deep red, sodic amphibole syenite. Dark green clots of amphibole with associated carbonate occupy the space of former quartz grains. Selective weathering out of the amphibole and carbonate produces a pitted surface.

Parbery (1984, p.13) reported evidence of fenitization up to 2 km from the Seabrook Carbonatite Complex but generally it is restricted to an aureole of several hundred metres width. He (Parbery, 1984, p.23, 24) described the fenitization process as one where quartz is replaced by prismatic pyroxene and the feldspars become turbid. The microcline loses its quadrille twinning and orthoclase with Carlsbad twinning may appear as carbonate and iron oxide appear along fractures (Parbery 1984, p.23).

Quartz is enclosed in masses of clinopyroxene, the feldspars are coated with iron oxide and broken into a mosaic of smaller crystals, the pyroxene varies in composition from aegirine augite to aegirine and the pyroxene may be enclosed in small masses of alkali amphibole (Parbery 1984, p.24). The fenitized granite contains traces of biotite, sphene, apatite and chlorite (Parbery 1984, p.24).

Parbery (1984, p.38, 133) presented microprobe data indicating that, in fenitized granite, the plagioclase has a composition of Ab_{98} to Ab_{99} and the potassium feldspar has a composition of Or_{31} to Or_{79} .

Microprobe analysis indicates that the amphibole in the fenites is richterite to magnesio-arfvedsonite, the pyroxene is a sodium augite to aegirine augite with

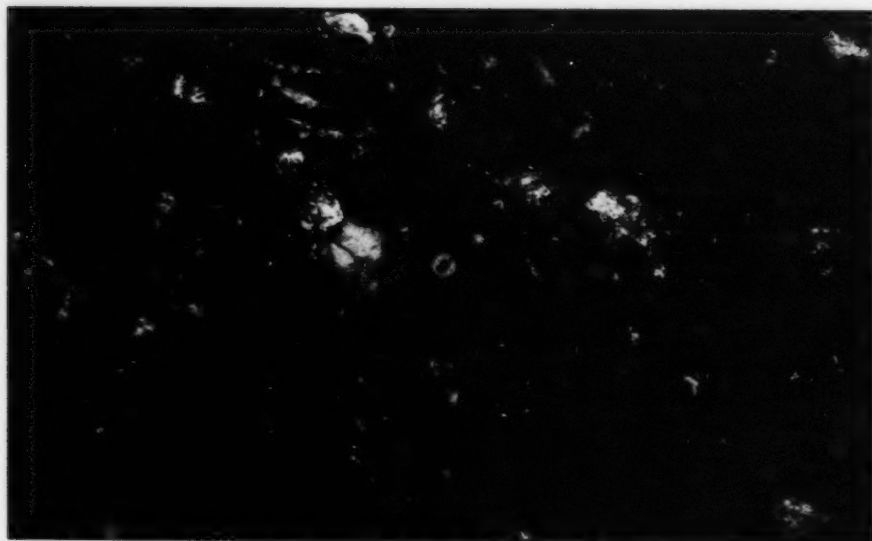


Photo 1. Breccia along east flank of Seabrook Lake Carbonatite Complex. Breccia is typical of contact area. This outcrop contains fragments of sovite. (Location P-4).

the acmite content increasing towards the rim of the grain (Parbery 1984, p.39, 42, 133, 138-142). The pyroxene has a composition of $\text{Di}_{80}\text{Hd}_{20}\text{Ac}_{20}$ to $\text{Di}_{10}\text{Hd}_{8}\text{Ac}_{82}$ (Parbery 1984, p.42).

Fenitized Granite Breccia

Along the southwest, west, east and southeast flanks of the Seabrook Lake Carbonatite Complex, fenitized granitic breccia (Unit 4) is in immediate contact with the rocks of the complex. In outcrop the breccia consists of clasts of altered granite set in a dark, fine-grained green to green-black matrix. The granitic clasts range in size up to 30 cm and display dark green reaction rims up to 1 cm wide. The clasts are angular to subrounded in form. Clasts of sovite, silicocarbonatite, and ijolite are sometimes present, however the breccia was also observed to be cut by sovite dikes leading to confusion as to the age relations of the breccia with respect to the rocks of the complex (Photo 1).

In one exposure of breccia near Parsons' (1961) location "A" the clasts were estimated to be 1-3% sovite, 3-4% ferruginous carbonate, 30-35% altered granite (no visible quartz), 10-15% silicocarbonatite, and 30-35% very fine-grained ijolite(?). The outcrop is cut by a banded, approximately 1 m wide, sovite dike with a northeast strike. Parsons (1961) also noted diabase clasts in the breccia.

The matrix visually appears to be rich in fine-grained pyroxene and contains clastic debris derived from milling and comminution of the enclosed clasts.

It is impossible to estimate a mineralogical mode. Albite, pyroxene (altered), biotite, apatite, magnetite, carbonate, pulverulent limonite, hematite, phlogopite, olivine (completely altered to a very fine-grained serpentine), acicular amphibole, and an unidentified, very fine-grained material occur within the breccia matrix. The predominant mineralogy is biotite-phlogopite, altered pyroxene, carbonate, and pulverulent limonite or hematite.

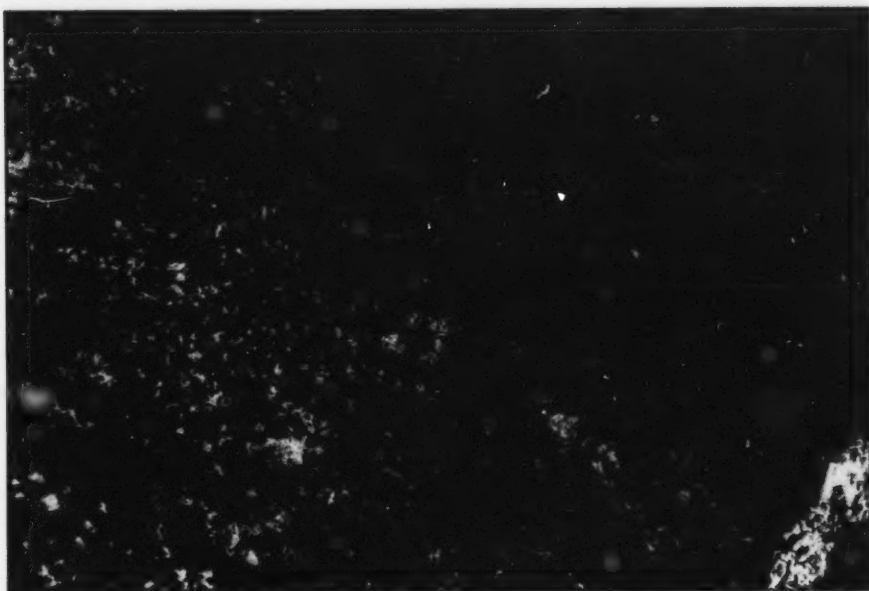


Photo 2. Typical weathered surface of ijolite. Location P-1.

Osatenko (1967) also reported the presence of disseminated pyrite and galena within the breccia matrix.

The zone of granitic breccia varies from a few metres to approximately 100 m in width. The granitic breccia zone and fenitized granite, if considered together as a unit, represent an easily recognizable zone of alteration with a width of at least 200 to 300 m. Evidence of fenitization is recognizable in all samples of granitic rock examined in thin section, consequently the true width of the alteration zone is unknown. The intensity of fenitization gradually fades into unaltered rock over a very broad zone which extends beyond the mapping completed during this project.

Ijolitic Rocks

A body of nepheline-pyroxene-bearing rock (Unit 5) forms the southward trending appendage of the Seabrook Lake Carbonatite Complex. This portion of the complex is well exposed and sampling is relatively easy. The rocks weather black, green-black, to mottled black and pink-purple (Photo 2). The colour of the weathered surface is dependant on the relative content of nepheline versus pyroxene. The darker coloured rocks contain more pyroxene. Biotite, commonly medium to coarse grained, forms up to 10% of some samples.

The rocks vary from fine to coarse grained and are generally equigranular. One occurrence of glomeroporphyritic ijolite contains rounded clots of nepheline up to 3 cm in diameter (Photo 3). Several outcrops have a faint, wispy, discontinuous banding due to the relative variation in pyroxene-nepheline content of the band. Irregular, coarse-grained, pegmatitic, nepheline segregations were noted in several outcrops (Photo 4). The subdued weathering of the nepheline with respect to the pyroxene imparts a rough surface to the outcrops.

Subrounded clasts of pyroxenite up to 10 cm in maximum dimension were noted in one outcrop. The pyroxene of the clasts appear identical to the pyroxene

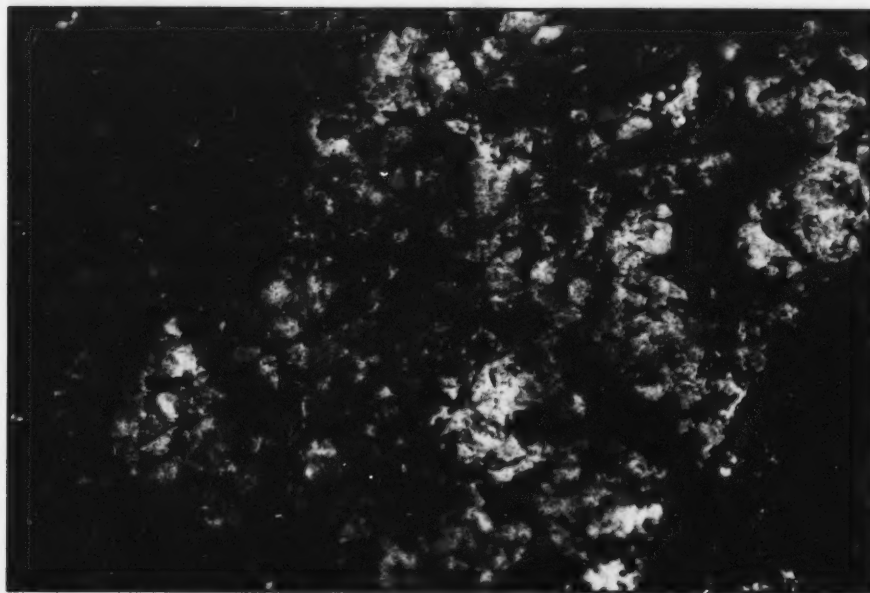


Photo 3. Spherical clots of nepheline in ijolite. Location P-2.

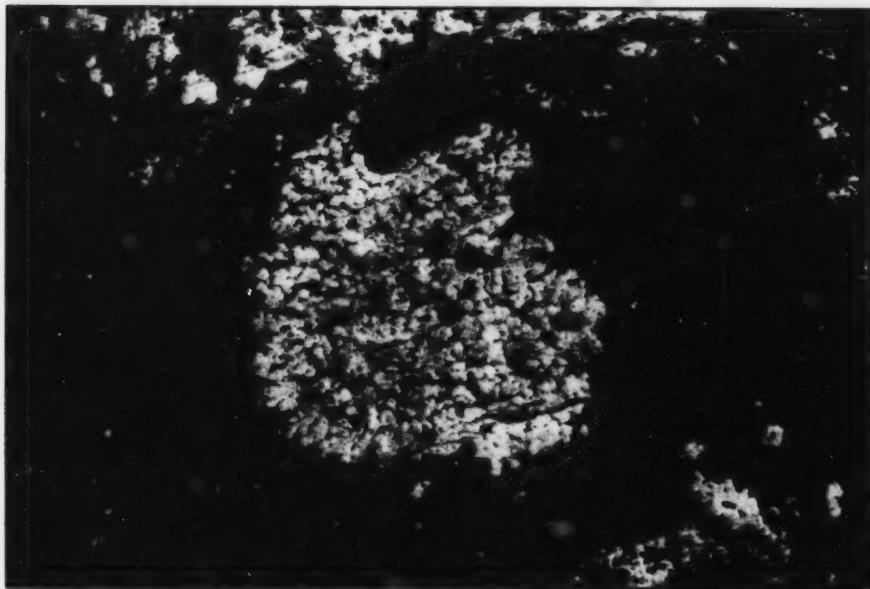


Photo 4. Urtite (nepheline) segregation in ijolite. Location P-1.

in the host ijolite rock. Darker coloured intersecting joints or fractures impart a pseudo-brecciated appearance to the occasional outcrop. This feature is likely due to late-stage deuteritic alteration along joints in the ijolite or alteration by fenitizing fluids from the younger carbonatite intrusion.

TABLE 2. MICROPROBE ANALYSES OF PYROXENES FROM THE SEABROOK LAKE COMPLEX (FROM MITCHELL 1972).

	SL 1		SL 2		SL 3
	C	R	C	R	C
SiO ₂	51.71	50.86	50.55	50.45	50.28
TiO ₂	0.94	0.47	1.02	0.51	1.21
Al ₂ O ₃	1.38	1.41	2.18	1.59	2.02
Fe ₂ O ₃ *	2.44	10.45	4.22	12.06	4.13
FeO	6.48	10.49	7.79	10.68	6.82
MnO	0.31	0.67	0.38	0.61	0.34
MgO	13.01	5.16	10.75	3.97	11.40
CaO	23.41	15.99	22.24	15.43	22.44
Na ₂ O	0.59	4.40	1.20	4.89	1.08
Total	100.27	99.90	100.33	100.19	99.72

	SL 4		SL 5	
	C	R	C	R
SiO ₂	51.54	49.97	50.78	50.59
TiO ₂	0.12	0.05	0.56	0.55
Al ₂ O ₃	1.13	1.84	1.73	1.59
Fe ₂ O ₃ *	6.83	12.69	1.44	12.12
FeO	6.86	11.03	17.94	8.65
MnO	0.45	0.63	0.27	0.52
MgO	10.21	3.64	5.51	5.58
CaO	20.66	15.47	22.79	15.79
Na ₂ O	2.11	4.80	0.86	4.67
Total	99.91	100.12	101.88	100.06

*Fe₂O₃ calculated from total iron by assuming all the Na is combined with Fe³⁺ as the acmite end member pyroxene.
C = core. R = rim.

Rocks visually classified in the field as pyroxenite or melteigite were, upon examination in thin section, reclassified as ijolite.

In thin section the ijolite (Unit 5) is estimated to consist of 20–50% pyroxene, 25–60% nepheline, and 0–20% biotite. Sphene is a common accessory mineral occurring as subhedral to euhedral wedge-shaped crystals in amounts up to 5%. Magnetite, as anhedral, disseminated grains in amounts up to 5%, is also a common accessory mineral. Apatite, albite, cancrinite, orthoclase, and carbonate are present in one or more thin sections.

The pyroxene is a pale green, anhedral to euhedral, aegirine-augite. The grains may be elongated or acicular in form and some of the larger grains have rims that are distinctly deeper green than the cores, implying a compositional zonation. The extinction angle may vary by 10° from core to rim of a well zoned grain. Locally the pyroxene poikilitically contains anhedral inclusions of red-brown biotite and magnetite and some grains have twin planes. Using microprobe techniques Mitchell (1972, p.418–420, Table 2) determined that the pyroxenes have salite cores and aegirine-augite rims.

Mitchell (1972, p.419) interpreted this compositional relationship as being due to the breakup of accumulate salite pyroxene reacting with later magma enriched in iron and alkalis. He suggested that previously formed pyroxene accumulates were broken up by magma expelled from another part of the magma chamber by filter pressing. The aegirine-augite overgrowths, biotite and

TABLE 3. MICROPROBE ANALYSES OF NEPHELINES FROM THE SEABROOK LAKE COMPLEX (FROM MITCHELL 1972).

	SL 1	SL 2	SL 3	SL 4
SiO ₂	42.15	42.65	41.48	42.22
Al ₂ O ₃	33.43	33.41	33.44	33.47
Fe ₂ O ₃ *	1.17	1.21	1.07	0.84
CaO	0.06	0.03	0.11	0.05
K ₂ O	7.06	7.04	7.37	6.85
Na ₂ O	16.19	16.10	16.02	16.32
Total	100.06	100.43	99.49	99.75

*Total Fe calculated as Fe₂O₃.

nepheline crystallized from this later magma (Mitchell 1972, p.420). The contact between the two pyroxene types is sharp and the core material varies widely in composition while the rim remains fairly constant in composition (Mitchell 1972, p.418-420).

Nepheline forms grains ranging from anhedral, interlocking to stubby, euhedral crystals. An unidentifiable, turbid mineral or cancrinite alteration may be present along the edges of the nepheline grains and along internal cleavage planes; however, the nepheline is generally fresh in appearance. The nepheline rarely contains small grains of pyroxene. The nepheline shows weakly discernible concentric zoning in several thin sections.

In one sample of ijolite with a glomeroporphyritic texture (see Photo 3), the nepheline glomeroporphyrites are composed of an interlocking mosaic of subhedral grains with curved grain boundaries. On the basis of microprobe data Mitchell (1972, p.416-418, Table 3) reported that the nepheline is homogeneous and iron-rich relative to most reported nepheline analyses. The nepheline-kalsilite solid solution series indicates crystallization temperatures below 500°C (Mitchell 1972, p.416). This temperature is likely in error since it is far below the currently accepted values at 1000 to 1100°C for ijolitic rocks which are based on homogenization temperatures of fluid inclusions in accessory apatites obtained from East African ijolites (LeBas 1981). The temperature reported by Mitchell is more consistent with values found in sovite rocks (LeBas 1981).

Biotite forms red-brown, ragged crystals which in places poikilitically enclose pyroxene, apatite, sphene, magnetite and nepheline. Biotite also occurs poikilitically enclosed within pyroxene, and as distinctly intergranular grains between pyroxene grains. The larger biotite grains have a sieve texture and are porphyroblastic. One thin section contains biotite in which some of the larger grains display a poorly developed kink banding of the (001) cleavage plane. Mitchell (1972, p.420-421, Table 4) reported that the compositions of the Seabrook Lake biotites, determined by microprobe analysis, show considerable variation in iron and magnesium content and are richer in titanium, barium and fluorine than biotite in some alkaline rocks.

The texture of the ijolite rocks is massive, equigranular, fine to coarse grained, hypidiomorphic. On the basis of mineralogy they are classified as ijolite or biotite ijolite. One sample contains sufficient orthoclase feldspar (15-20%) to be classed as malignite. In this sample, the orthoclase occurs as clear interstitial grains in part poikilitically enclosing stubby, subhedral nepheline crystals and elongate, subhedral pyroxene. The texture is reminiscent of some malignite samples observed by the author from the Poohbah Lake and Nemegosenda Lake Alkaline Rock Complexes (Sage 1988, 1987).

TABLE 4. MICROPROBE ANALYSES OF BIOTITES FROM THE SEABROOK LAKE COMPLEX (FROM MITCHELL 1972).

	SL 2	SL 3	SL 4	SL 5
SiO ₂	35.89	34.65	35.40	35.26
TiO ₂	4.96	5.02	5.35	5.73
Al ₂ O ₃	12.43	14.04	11.39	11.68
FeO*	19.63	14.76	24.39	27.11
MnO	0.33	0.22	0.48	0.47
MgO	11.67	15.47	10.22	7.48
Na ₂ O	0.36	0.68	0.33	0.40
K ₂ O	8.97	8.51	9.25	9.06
BaO	1.15	1.69	0.29	0.54
F	1.61	1.33	1.41	1.37
Total	97.00	96.37	96.51	99.10

*Total Fe calculated as FeO.

Osatenko (1967) reported the presence of black garnet which he identified as high titanium-bearing andradite. The author did not observe garnet in the 19 thin sections from samples believed representative of this unit. The author has, however, observed abundant titanium-rich garnet in similar rocks from other carbonatite complexes and its presence here would be expected.

Studies by Parbery (1984, p.27) indicate that the ijolite is composed of pyroxene, biotite, and nepheline with traces of carbonate, apatite, sphene and opaques. Within the melteigite phase of the ijolites Parbery (1984, p.27) reported that the pyroxene has an augite core and aegirine-augite rim. He observed ijolite cutting melteigite. Including data by Mitchell (1972), unpublished data by G. Medaris, University of Wisconsin, and his data, Parbery (1984, p.38) determined an average nepheline composition of $\text{Ne}_{77.4}\text{Ks}_{21.5}\text{Q}_{1.0}$ on a Ne-Ks-Qz diagram. Parbery (1984, p.34, 38, 131) reported microprobe analyses of the nepheline and observed minor alteration of the nepheline to cancrinite and zeolite.

On the basis of microprobe data Parbery (1984, p.39, 136) noted that biotite is more iron-rich in the ijolite than in associated mafic breccia and sovite. He also determined the pyroxene to have a composition of $\text{Di}_{79}\text{Hd}_{19}\text{Ac}_2$ to $\text{Di}_{27}\text{Hd}_{38}\text{Ac}_{37}$ with Na_2O plus Fe_2O_3 increasing from core to rim (Parbery 1984, p.42, 138-142).

Carbonatite Rocks

Sillicocarbonatite (With Subordinate Mafic Breccias And Sovite)

The northern bulbous portion of the Seabrook Lake Carbonatite Complex was mapped by Parsons (1961) as mafic breccia. The rocks within this area are mineralogically heterogeneous and locally display a brecciated appearance. The mineralogical and textural heterogeneity within closely spaced samples prevents any rigorous classification of the rocks within this area and the delineation of lithologic units. If one rock name were to be applied to this map unit as a whole, it would be sillicocarbonatite. Parsons (1961) reported the presence of fluorite in these rocks and considered them to be at least in part highly altered granite breccias.

The rocks of Unit 6 are fine to coarse grained, weather black to mottled white and black, and are very poorly exposed. Soils covering this map unit are

generally rich in mica and magnetite. No estimate of average mineralogic composition is possible.

In thin section the rocks are fine to coarse grained, equigranular to inequigranular-seriate, allotriomorphic to hypidiomorphic, with straight to curved grain boundaries. The following minerals have been identified in one or more thin sections: carbonate, biotite, phlogopite, magnetite, sphene, clinopyroxene, apatite, acicular amphibole, garnet and an unidentified, turbid, alteration product. Osatenko (1967) reported the presence of chlorite, hematite, brookite, pyrite, chalcopyrite, sphalerite and galena within this unit. Optical work by Osatenko (1967) indicated that the acicular amphibole is a magnesio-riebeckite.

Parbery (1984), like the author, found the silicocarbonatite - mafic breccia to be heterogeneous. He noted that tabular biotite and prismatic arfvedsonite amphibole are common and that a carbonate-chlorite assemblage pseudomorphs the amphibole. Minor interstitial quartz may be present (Parbery 1984, p.28).

Microprobe analysis indicates that the MgO in biotite in the mafic breccias increases from core to rim, that TiO_2 remains constant and that the biotite in the breccia contains less iron than the biotite in the ijolite (Parbery 1984, p.39, 136).

The mafic breccia observed by Parbery (1984, p.14) is locally composed of 60% fragments which vary in size from 0.5 to 500 cm.

Sovite

Sovite (Unit 7) is not a dominant rock type at the Seabrook Lake Carbonatite Complex. The best exposures of sovite are dikes which principally cut the silicocarbonatite and mafic breccia (Unit 6). Parsons (1961), however, also observed sovite cutting fenitized granite. The sovite displays a distinct mineralogic banding, weathers light brown, and generally is medium grained (Photo 5).



Photo 5. Banded carbonatite consisting of mixed sovite and silicocarbonatite with xenoliths of various alkalic rock types. Location P-3.

In thin section the sovite is fine to medium grained, equigranular, massive, allotriomorphic, with straight grain boundaries. Carbonate forms an interlocking mosaic of anhedral grains. Acicular amphibole, chlorite, limonite, hematite, albite, magnetite, apatite, and biotite were noted in one or more thin sections of sovite rocks. Osatenko (1967) considered the amphibole to be a magnesio-riebeckite.

Within the northwest corner of the complex is an area of hematite-rich rock. This rock weathers a deep red and is characterized by an abundance of pulverulent earthy hematite. A thin section of this rock type prepared from samples collected by the author during an earlier project (Thurston *et al.* 1977) contains medium-grained, euhedral, carbonate crystals with hematite along the grain boundaries. The rock is estimated to consist of 40% hematite and 60% carbonate. The hematite-carbonate displays an unusual texture within the rock giving it a distinct "bird track" or "herringbone" pattern. Mapping by Parsons (1961) indicated that this hematitic zone is approximately 90 by 90 m in surface area. Analysis of a specimen of this hematite-rich rock collected during Operation Chapleau disclosed an unusually high rare earth element content. Analysis by the Geoscience Laboratories, Ontario Geological Survey, disclosed 0.47% cerium oxide and 0.22% lanthanum oxide. No rare earth element-bearing mineral was identified.

Parbery (1984, p.33, 39, 137) determined that the amphibole in the sovite is riebeckite on the basis of microprobe data.

Dike Rocks

Several outcrops were classified as "miscellaneous rocks" by Parsons (1961). These exposures were not visited by the author. On the west shore of Seabrook Lake and north of the main peninsula, there are two outcrops of a uniform, medium-grained rock consisting of about equal proportions of brown biotite and a light green silicate mineral (Parsons 1961). Parsons considered these exposures to be part of a dike. They occur in an area of granite, fenitized granite, and diabase.

Parsons (1961) described a carbonate dike on the west shore of Seabrook Lake in an area of granite and diabase 900 m north of the main alkaline mass. This dike contains zones of coarse calcite crystals, and biotite along the margins of the dike. Even though its contacts are not exposed, it was estimated to be 10.5 m wide (Parsons 1961).

Parbery (1984, p.15, 16) reported that carbonatite dikes cut quartz monzonite, fenite, and mafic breccia. The dikes display a foliation dipping towards the carbonatite complex, have sharp contacts with no evidence of replacement or chilling and are 3 to 20 m wide. An olivine lamprophyre dike 3 to 15 cm wide cuts the ijolite between Ogsten and Belsey Lakes (Parbery 1984, p.16).

Mafic Alkaline Dikes

Mafic alkaline dikes cut the granitic rocks in two places: in the southeast corner of Centre Bay, and at the northwest corner of Southwest Bay. Parsons (1961) reported that mafic alkaline dikes cut granite breccia on the extreme south flank and another cuts mafic breccia on the north flank of the complex.

The dikes weather subdued with respect to the granitic rocks, and may display a weakly ribbed surface from differential weathering. On weathered surfaces they are black, brown or grey in colour. The dikes are rich in carbonate and in

the southeast corner of Centre Bay a fine-grained, biotite-bearing, grey carbonate-rich dike is cut by a red-brown weathering, fine-grained, carbonate-rich dike. There are at least two ages of emplacement of the mafic alkaline dikes. These dikes locally contain angular inclusions of granitic rock.

A thin section was prepared from one of the dikes located at the northwest corner of Southwest Bay. This dike is 22 cm wide and strikes 225° , dipping 72° north. The dike cuts massive granitic rocks. In thin section the dike consists of about 40% fine-grained biotite, 40% acicular amphibole (actinolite?) and 15% carbonate. Accessory pyrite and magnetite are present.

PETROLOGY

Collection of samples for chemical analysis was restricted to the ijolite phase of the complex since the carbonatite phase is too heterogeneous. Consequently, the analyses and the calculated norms and average compositions (Tables A-2 to A-6, Appendix A) can only be used for comparison of ijolite compositions with other complexes and not for establishing possible differentiation trends. The Seabrook Lake Carbonatite Complex is enveloped in an extensive halo of fenite; therefore, extensive loss of alkalis and volatiles from the original carbonatite magma has occurred. Alteration along fractures within the ijolite unit suggests that this unit has also been subjected to some metasomatic activity.

Parbery (1984, p.144-147) reported major and minor element compositions and normative mineralogy for mafic breccia, sovite, ijolite, quartz monzonite, fenitized quartz monzonite and fenite. Conclusions reached by Parbery (1984, p.64, 66-75, 86), based on rock chemistry, are as follows:

1. Within the mafic breccia increasing K_2O with respect to SiO_2 is due to increasing biotite content.
2. Within the ijolite a decrease in K_2O with respect to increasing SiO_2 is due to decreasing biotite content.
3. Fenitization of quartz monzonite resulted in an increase in MgO and Fe_2O_3 .
4. Within rocks of the complex, Nb, Sr, Zr and Y increase with SiO_2 , V and Ba are somewhat enriched, Ni, Cr are not enriched, and Cu and Rb values are scattered.
5. Niobium, Sr and Zr enrichment parallel CaO and to a lesser extent P_2O_5 contents.
6. The ijolites display an increase in Rb which is due to an increase in K_2O .
7. During fenitization Sr increases dramatically over unaltered quartz monzonite, possibly due to higher CaO in the fenites than quartz monzonites.
8. The rare earth elements are richest in sovite, followed by mafic breccia, then ijolite. There is some depletion of rare earth elements in the fenites with respect to unaltered quartz monzonite. This depletion may be due to feldspar alteration by a non rare earth-bearing fenitizing fluid.
9. Alkali elements are lost from the alkalic magma to the quartz monzonite during fenitization.

Other conclusions resulting from the field work and chemical data presented by Parbery (1984, p.86-120) are as follows:

1. Assume a parental carbonated melanephelinite magma that undergoes liquid immiscibility.
2. The mafic alkaline magma formed the ijolite, urtite and melteigite series. Ijolite cuts melteigite.
3. Sovite is emplaced after ijolite.
4. Mafic breccia is formed by forceful emplacement of mafic alkaline magma which incorporated wall rock.
5. The path of fenitization is one of Si and Al loss and corresponding increase in alkalis, Ca, Mg, Fe and volatiles.
6. Using Gresen's equations of mass transfer, fenitization can result in a decrease in volume of 21%.
7. Fenitizing fluids did not contain rare earth elements perhaps implying a low CO₂ content that would be required to complex rare earth elements.
8. The fenitization process may be related to the ijolite and not the carbonatite. The ijolite is not fenitized where cut by sovite dikes.
9. The Seabrook Carbonatite Complex is enveloped in a sodium fenite halo.
10. The quartz found in some Seabrook sovites may be due to a late stage silicification by back diffusion of silica from the wall rocks.
11. The fenitization process may have taken place at a temperature lower than 500°C.

The suggestion by Parbery (1984) that fenitization may be related to ijolite emplacement rather than carbonatite is at variance to observations by the author at other complexes. Carbonatite complexes such as Borden Township and Firesand River are dominantly carbonate in composition and have well developed fenite haloes. At the Prairie Lake Carbonatite Complex, carbonatite veins have reacted with the ijolite rocks, forming biotite along the carbonatite-ijolite contacts.

METAMORPHISM

The enclosing granitic rocks lack petrographic evidence of recrystallization and/or metamorphism. A weak, wavy extinction to the quartz suggests that a very mild stress has been imposed on the rock. Marginal to the Seabrook Lake Carbonatite Complex metasomatism has been pervasive and the granitic rocks have undergone extensive alteration and replacement. The fenitized granite and granite breccia are described above.

Within the rocks of the complex the large porphyroblastic biotite grains within the ijolitic rocks may represent a late-stage autometamorphic event. The lack of metamorphic textures within the enclosing granite implies that these large porphyroblasts are intimately related to the formation of the ijolitic rocks and are not the product of regional metamorphism.

The development of sodium and iron rich pyroxenes within the fenitized rocks indicates that the metasomatising fluids were rich in iron and sodium. These fluids selectively replaced quartz and thus have the effect of decreasing the overall silica content of these rocks.

STRUCTURAL GEOLOGY

REGIONAL SETTING

A number of regional linears intersect at the site of the Seabrook Lake Carbonatite Complex. The complex may represent the southernmost alkalic magmatism associated with faulting of the Kapuskasing Structural Zone. The complex lies south of the structural zone's presently interpreted southern boundary but is on strike with it or with faults associated with it.

INTERNAL STRUCTURES

Banding is present within the sovitic rocks of the complex and is defined by variations in silicate and carbonate mineral content. The measured trends are too variable to warrant an interpretation. The banding has a steeply dipping attitude.

Faint discontinuous streaking of some ijolitic rocks implies compositional variation within this rock suite. The banding, however, is too faint to determine an attitude.

A north-trending linear bisects the complex and on the basis of topography, interruption of magnetic trends, and offset of rock formations, it is interpreted to be a fault (Parsons 1961).

The complex is enclosed in an envelope of brecciated granite, and altered granite. Parsons (1961) suggested that some of these breccias may be intrusive or rheomorphic in origin.

RECOMMENDATIONS FOR FUTURE STUDY

Future work should be directed to obtaining additional mineral compositions and modifying petrologic models. The mineralogic work of Osatenko (1967) was principally with X-ray diffraction techniques. These techniques are not precise when dealing with amphibole and pyroxene compositions. Microprobe work supplemental to that of Mitchell (1972) is desirable; a large volume of microprobe data has recently been presented by Parbery (1984) who also determined mineral compositions of the lithologic units. The mineralogy of the complex has been largely defined by the work of Parbery (1984). Additional microprobe studies may be warranted. A more refined isotopic age is desirable so that a better comparison can be made with alkalic rock - carbonatite complexes located north of the Seabrook Lake Carbonatite Complex.

MAGNETIC AND RADIOACTIVE DATA

Parsons (1961, p.22) summarized the ground magnetic data for the complex as follows:

- "1. A magnetic aureole occurs around the central core and is offset by a north-south-trending fault. This aureole corresponds to the area underlain by rocks called mafic breccia.
- "2. The magnetic anomaly extending south from this central area is underlain by ijolites and pyroxenites, although these rocks are not all magnetic.
- "3. The numerous northwesterly trending magnetic anomalies in the granite area disappear as the carbonate-alkaline complex is approached; all the outcrops found on these trends are diabase dikes."

Parsons (1961, p.23) reported that radioactivity is weak over most of the area and that it reaches a maximum of 10 times background. Although the pyrochlore-bearing areas are radioactive, the best assays for niobium do not correspond with the highest radioactive readings (Parsons 1961).

Economic Geology

Samples collected during a previous project (Thurston *et al.* 1977) returned 0.01 to 0.03% niobium, 0.07 to 0.47% cerium oxide, and 0.04 to 0.22% lanthanum oxide. The U_3O_8 equivalent was 0.03 to 0.005%. Parsons (1961) reported niobium assays ranging from 0.01 to 0.33%; the best assay came from fenitized granite at his location "B". A sample of carbonatite collected during a previous project (Thurston *et al.* 1977) at this same location returned 0.01% niobium.

Parsons (1961) reported that niobium mineralization at Seabrook Lake was first identified by George Gilbert of Algoma Ore Properties Limited in a magnetite-rich sample. The International Minerals and Chemical Corporation (Canada) Limited have documented the presence of minor phosphate mineralization. Even though the Seabrook Lake Carbonatite Complex has been explored many times, mineralization of economic interest has not yet been delineated.

PROPERTY DESCRIPTIONS

BONIN, ISAIC [1957]

Within file SSM 220 (Resident Geologist's Office, Ministry of Northern Development and Mines, Sault Ste. Marie), are logs for five diamond drill holes totalling 180 m. This drilling was done on former claim SSM 45259. The site of this drilling could not be determined. The drill logs indicate that mineralization of economic interest was not encountered.

BUSSINEAU, W. [1955]

Four diamond drill holes totalling 173 m were drilled on former claims SSM 27730, 27724 and 27723 to test for niobium mineralization. The higher niobium values were reported to occur in areas that have abnormal radioactivity and contain concentrations of magnetite. Parsons (1961) reported that W. Bussineau did bulldozer stripping in an attempt to extend the showings of hematite-bearing rock. Records within the Assessment Files Research Office (Ontario Geological Survey) indicate that most of this work was likely done in the search for niobium. A geological report within the files of the Resident Geologist at Sault Ste. Marie indicates that some trenching was completed and that four selected grab samples assayed 0.60, 1.50, 4.70 and 10.30% niobium oxide. Niobium assays reported by Bussineau for core samples from the 4 holes completed indicate trace to undetectable amounts.

CANPAC MINERALS LIMITED - GUNNEX LIMITED [1971]

In 1971 Canpac Minerals Limited and Gunnex Limited completed a joint exploration program for niobium on the complex. The companies cut a grid, completed a geological survey, a geochemical survey, a magnetometer survey, and scintillometer survey.

On the basis of the magnetometer survey the company interpreted the complex to be basin shaped with contacts dipping steeply inward.

The results of scintillometer survey indicated that the highest radioactivity was associated with the silicocarbonatite and mafic breccia (author's unit 6) and that some high readings occur within fenitized granite.

The geochemical soil survey indicated that the more anomalous niobium values occur along the margins of the complex. The companies also reported niobium values in ppm's for 88 rock samples whose locations are shown on a geological map accompanying their assessment submission. The companies reported that samples taken from old pits and trenches returned niobium values of 0.02 to 0.90%. Of the 28 niobium assays reported on rock samples, only 4 were in excess of 0.10%.

The work by these two companies disclosed locally high niobium values and diamond drilling was recommended in three areas, but not completed. The areas of anomalous niobium values have been indicated on the map (Figure 3, Chart A).

INTERNATIONAL MINERALS AND CHEMICAL CORPORATION (CANADA) LIMITED [1974]

Using the Canpac-Gunnex grid, the International Minerals and Chemical Corporation (Canada) Limited completed a geological survey of the complex in 1974. Nineteen samples were collected at random and assayed for P_2O_5 by the company. The samples averaged 1.39% P_2O_5 with the highest value being 5.16% and the lowest 0.10% occurring within 130 m of each others at Parsons' (1961) location "A". The values are highly erratic, with the most consistent values being noted in the relatively homogeneous ijolite mass at the south end of the complex. The P_2O_5 values within this unit were consistently between 1.0 and 2.0%. The company was not encouraged by the results and work was terminated.

JOUBIN, F.R. [1957]

A geochemical soil survey was completed by F.R. Joubin and samples were tested for heavy metals and niobium. A limited amount of trenching was done to test anomalous areas. Work was concentrated on the main peninsula jutting into Seabrook Lake, covered by former claims SSM 67142, 67141, 67151, 67143 and 67140. The higher niobium values were reported to occur in association with concentrations of magnetite. No additional work was reported.

TARBUTT MINES LIMITED [1957]

Tarbutt Mines Limited completed a grid system and magnetometer survey over the Seabrook Lake Carbonatite Complex. The company likely completed at least 16 packsack diamond drill holes but the author has been able to locate the logs of only 11 in the Assessment Files Research Office of the Ontario Geological Survey.

The company completed 3 holes on claim SSM 42727 located on the south side of a small bay on the east side of Seabrook Lake. This drilling totalled 37.1 m and encountered carbonatite, purple fluorite, pyrite and siderite in association with diabase. Sketch maps accompanying the logs indicate 4 holes were drilled, however the log for the fourth hole could not be located.

On claim SSM 42908 the company completed two holes totalling 16.7 m that encountered granite and diabase. One hole, completed on claim SSM 42909, totalled 8.4 m in length and encountered granite and diabase. Five holes totalling 49.5 m were drilled on claim SSM 42910 south of Sigel Lake, Rollins Township. The logs recorded mostly granite and diabase, however carbonate veinlets and brecciation, both of which may be related to the complex, were noted.

Available drill records indicate that the 11 holes for which records could be found totalled 111.7 m.

TAYLOR, K.R. AND AHEARN, R. [1956-1957]

Files within the Assessment Files Research Office (File 6.5.299) under the above heading contain the logs for the five holes previously mentioned under the Bonin property. Sketch maps accompanying the logs would indicate some pitting was also completed.

Within file 63.301, records for 3 diamond drill holes totalling 122.4 m are present along with a sketch map indicating some trenching and stripping was completed. This work was done on claim SSM 45821. This claim could not be precisely located with respect to the complex. The drill logs indicate the holes encountered traces of chalcopyrite.

TAYLOR, L.M. [1957]

Lafayette M. Taylor completed two diamond drill holes totalling 108.6 m on claim SSM 46280. The location of these drill holes and any mineralization encountered is unknown.

RECOMMENDATIONS FOR THE PROSPECTOR

Phosphate and niobium values have been obtained within the complex (Parsons 1961). The phosphate values are erratic and generally not very high (private files, International Minerals and Chemical Corporation (Canada) Limited).

The joint Canpac Minerals Limited - Gunnex Limited program outlined three areas worthy of testing for niobium. These zones are not likely, however, to contain a large tonnage of niobium mineralization.

Development of this complex could most likely happen if an area could be delineated from which several mineral commodities could be produced, that is, pyrochlore, apatite and vermiculite.

A hematite-rich carbonate sample from the complex returned 0.47% cerium oxide and 0.22% lanthanum oxide (Thurston *et al.* 1977) suggesting potential as a source for rare earth elements.

Appendix A — Petrographic Descriptions, Chemical Analyses, Normative Compositions, and Statistical Compositions of Lithologic Units of the Seabrook Lake Carbonatite Complex.

TABLE A-1. PETROGRAPHIC AND FIELD DESCRIPTIONS OF
WHOLE-ROCK SAMPLES* FROM THE SEABROOK LAKE CARBONATITE
COMPLEX.

Reference No. 352

Sample No. SB7-2

Ijolite

Field Description. Fine to medium grained, inequigranular, massive, and homogeneous. Biotite appears poikiloblastic and occurs in grains up to 8 mm in diameter. Weathered and fresh surfaces are black. Relative nepheline and pyroxene ratios vary slightly across the outcrop. Map unit 5.

Petrographic Description. Fine to medium grained, inequigranular-seriate, hypidiomorphic. Apatite forms tiny euhedral crystals poikilitic in pyroxene, biotite, and nepheline. Magnetite forms anhedral grains poikilitic in biotite, nepheline, pyroxene, and is commonly intergranular to pyroxene grains. Pyroxene is aegirine-augite, anhedral to subhedral, sometimes weakly zoned. Biotite forms anhedral ragged grains with poikilitic pyroxene, and magnetite. Nepheline is fresh and forms anhedral to subhedral grains; some contain small poikilitic pyroxene. Some nepheline forms leucocratic areas consisting of composite grains. Sphene(?) occurs as anhedral grains enclosing and engulfing pyroxene.

Reference No. 353

Sample No. SB7-3

Ijolite

Field Description. Fine to medium grained, equigranular, massive. Weathered and fresh surfaces are black. Relative nepheline and pyroxene may vary slightly across the outcrop. Map unit 5.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic. Magnetite is anhedral and disseminated. Sphene forms subhedral to euhedral wedge-shaped crystals. Biotite forms anhedral, irregular, interstitial, reddish-brown grains with poikilitic magnetite, pyroxene. Pyroxene is aegirine-augite, elongate, anhedral to subhedral, commonly with colourless cores and green rims. Nepheline forms anhedral grains, interlocking with nepheline and pyroxene.

Reference No. 354

Sample No. SB7-8

Ijolite

Field Description. Fine to coarse grained, massive, inequigranular-seriate. Biotite occurs in association with carbonate in areas of slight coarsening of texture. In most of the rock, biotite occurs in poikiloblastic appearing booklets. Map unit 5.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic. Biotite forms anhedral, irregular, ragged grains enclosing pyroxene and more rarely nepheline. Nepheline forms anhedral to euhedral grains, which are generally fresh. Pyroxene is aegirine-augite, elongate, subhedral to anhedral in form with larger grains zoned from dark green rims to pale green to colourless cores. Traces of disseminated euhedral magnetite are present.

Reference No. 355

Sample No. SB7-9

Ijolite

Field Description. Fine to medium grained, inequigranular-seriate. Biotite occurs in poikiloblastic appearing grains up to 8 mm in diameter. Weathered surfaces are mottled pink and black. Fresh surfaces are black. Map unit 5.

*All samples are from outcrops. Reference numbers for samples are plotted on Figure 3 (Chart A).

CARBONATITE - ALKALIC ROCK COMPLEXES: SEABROOK LAKE

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic. Mafic minerals are slightly erratic in distribution throughout rock. Calcite is anhedral and interstitial. Magnetite is anhedral and disseminated. Biotite is minor and occurs as interstitial grains. Pyroxene is aegirine-augite, elongate, anhedral to subhedral in form. Nepheline is fresh, anhedral to subhedral, forming an interlocking mosaic with pyroxene.

Reference No. 356

Sample No. SB7-13

lijiite

Field Description. Coarse grained, equigranular, massive. Weathered and fresh surfaces are mottled pink and black. Map unit 5.

Petrographic Description. Fine to medium grained, massive, equigranular, hypidiomorphic tending to allotriomorphic. Sphene forms subhedral to euhedral crystals generally displaying a good parting. Carbonate is minor, anhedral and interstitial. Biotite forms ragged anhedral grains enclosing pyroxene and more rarely enclosing nepheline. Nepheline is generally fresh, anhedral to subhedral in form. Local minor cancrinite alteration occurs along edges of nepheline grains. Pyroxene is elongate aegirine-augite with generally ragged edges. Larger grains have pale cores implying compositional zonation.

Reference No. 357

Sample No. SB7-16

lijiite

Field Description. Fine to coarse grained, inequigranular-seriate. Biotite occurs in porphyroblastic grains up to 1 cm across. Weathered surfaces are mottled pink and black. Fresh surfaces are black. Map unit 5.

Petrographic Description. Fine to medium grained, massive, equigranular, hypidiomorphic. Minor euhedral sphene is present. Biotite forms brown, anhedral, ragged grains with poikilitic pyroxene and nepheline. Pyroxene is an aegirine-augite, subhedral to euhedral in outline, elongate; the larger grains have pale green cores, darker green rims. Nepheline forms anhedral to subhedral fresh grains.

Reference No. 358

Sample No. SB7-17

lijiite

Field Description. Medium grained, massive, equigranular. Weathered surfaces are pink and black; fresh surfaces are mottled pink and black. Map unit 5.

Petrographic Description. Medium grained, equigranular, massive, hypidiomorphic. Sphene is anhedral to subhedral and minor. Biotite forms irregular anhedral grains with poikilitic pyroxene and nepheline. Pyroxene forms subhedral to euhedral crystals with strong zoning and well developed twinning. Cores are pale green and rims are dark green; extinction angle between cores and rims varies by at least 10°. Pyroxene is an aegirine-augite. Nepheline is anhedral to euhedral, generally fresh with minor alteration to cancrinite along grain boundaries. Nepheline may poikilitically enclose pyroxene.

Reference No. 359

Sample No. SB7-22

lijiite

Field Description. Fine to coarse grained, inequigranular-seriate. Biotite appears porphyroblastic and occurs in grains up to 8 mm in diameter. Weathered surfaces are mottled pink and black, fresh surfaces black. There is some slight variation in nepheline content imparting a very weak banding to the outcrop. Map unit 5.

Petrographic Description. Fine to medium grained, inequigranular-seriate, hypidiomorphic. Biotite forms reddish brown, ragged, irregular grains interstitial to pyroxene, sphene, and nepheline. Sphene is anhedral and envelops pyroxene. Pyroxene is aegirine-augite, anhedral to euhedral and acicular in form. Pyroxene is zoned with colourless cores and green rims. Nepheline is fresh and forms anhedral grains interlocking with pyroxene and other nepheline grains. Minor apatite forms euhedral crystals.

Reference No. 360

Sample No. SB7-27

lijiite

Field Description. Fine to coarse grained, inequigranular-seriate. Biotite occurs in poikiloblastic appearing grains up to 8 mm in diameter. Weathered surfaces are mottled pinkish-black, fresh surfaces black. Map unit 5.

Petrographic Description. Fine to medium grained, massive, equigranular, hypidiomorphic. Spinel forms wedge-shaped euhedral crystals with poikilitic nepheline and pyroxene. Orthoclase forms large, optically continuous grains with poikilitic pyroxene and nepheline. Biotite forms anhedral ragged grains with poikilitic pyroxene and nepheline. Pyroxene is green, elongate, anhedral to subhedral in form. Nepheline forms anhedral to euhedral crystals with minor alteration to cancrinite along grain boundaries.

Reference No. 381
Sample No. SB7-29

Ijolite

Field Description. Fine to medium grained, equigranular. Weathered surfaces are black, fresh surfaces grey black. Local areas of outcrop are richer in nepheline. Map unit 5.

Petrographic Description. Fine to medium grained, massive, equigranular, hypidiomorphic. Spinel forms wedge-shaped euhedral crystals; several contain poikilitic pyroxene. Pyroxene is aegirine-augite, elongated, anhedral to euhedral in form, with pale green cores and dark green rims. Nepheline forms anhedral to euhedral grains, fresh and unaltered. Biotite is minor forming anhedral grains intergranular to the pyroxene.

Reference No. 382
Sample No. SB7-30

Ijolite

Field Description. Fine to medium grained, equigranular. Some pegmatitic stringers consist of coarse grained carbonate plus biotite. Pegmatitic stringers were removed from sample before analysis. Weathered and fresh surfaces are black with a tinge of pink. Outcrop contains irregular wispy segregations of coarser grained nepheline (urtite). Map unit 5.

Petrographic Description. Fine grained, equigranular, massive, hypidiomorphic. Pyroxene is aegirine-augite, anhedral to subhedral in form and pale green in colour. Minor poikilitic magnetite is present. Magnetite forms disseminated grains with anhedral outlines. Biotite forms irregular, ragged, reddish brown grains with poikilitic pyroxene, magnetite and nepheline. Nepheline is anhedral to subhedral in form, commonly with concentric zoning.

Reference No. 383
Sample No. SB7-31

Ijolite

Field Description. Fine to medium grained, inequigranular-seriate. Rock displays slight textural inhomogeneity. Biotite is slightly clotty. Weathered and fresh surfaces are black with a tinge of pink. Local porphyritic areas in outcrop contain nepheline crystals up to 5 mm. Map unit 5.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic. Magnetite forms anhedral interstitial grains, commonly intergranular to pyroxene. Biotite forms anhedral, ragged grains with poikilitic pyroxene and magnetite. Biotite is reddish brown in colour. Pyroxene forms anhedral to subhedral pale green grains of aegirine-augite. Spinel forms wedge-shaped euhedral crystals. Nepheline forms anhedral to subhedral grains with traces of alteration to cancrinite. A thin zone of recrystallized nepheline and pyroxene implies some cataclasis.

Reference No. 384
Sample No. SB7-48

Ijolite

Field Description. Glomeroporphyritic. Glomeroporphyritic of pink nepheline form circular aggregates up to 3 cm in diameter in a matrix of typical dark biotite ijolite. Weathered and fresh surfaces display circular pink clots of nepheline in a pinkish black matrix. Map unit 5.

Petrographic Description. Fine grained, massive, equigranular, glomeroporphyritic, hypidiomorphic. Biotite forms reddish brown, anhedral, ragged grains with poikilitic pyroxene and magnetite. Pyroxene forms anhedral to subhedral light green grains of aegirine-augite. Nepheline forms anhedral grains, interstitial to pyroxene and large composite clusters of grains with curved grain boundaries.

Reference No. 385
Sample No. SB7-49

Ijolite

Field Description. Medium grained, massive, equigranular. Weathered and fresh surfaces are black with a tinge of pink. Local areas contain aggregates of nepheline crystals imparting a glomeroporphyritic appearance to the outcrop. Map unit 5.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic. Biotite forms ragged, anhedral grains with poikilitic pyroxene, nepheline and magnetite. Magnetite forms anhedral disseminated grains. Pyroxene is anhedral to subhedral aegirine-augite and contains poikilitic biotite and nepheline. Nepheline forms anhedral to subhedral grains with turbid alteration along cleavage planes.

Reference No. 366
Sample No. SB7-53

Melteigte

Field Description. Fine to coarse grained, massive, inequigranular-seriate. Biotite occurs in poikiloblastic grains up to 7 mm in diameter. Weathered and fresh surfaces are black with a pink mottling. Locally porphyritic areas of outcrop contain nepheline crystals up to 1 cm. Map unit 5.

Petrographic Description. Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic. Spinel is anhedral, interstitial to pyroxene. Pyroxene is anhedral to subhedral and weakly zoned. Biotite forms reddish brown ragged crystals, enclosing pyroxene and apatite and locally partially replacing pyroxene. Nepheline forms anhedral to subhedral crystals interlocking with pyroxene and other nepheline grains. Nepheline is weakly altered along cleavage planes. Traces of interstitial carbonate are present.

Reference No. 367
Sample No. SB7-60A

Porphyritic Ijolite

Field Description. Fine to medium grained, inequigranular-porphyritic-seriate. Nepheline crystals up to 7 mm compose approximately 20% of the rock. Nepheline is pink in colour and weakly zoned. The matrix is ijolite which is black, tinged with pink. Weathered surfaces are mottled pink and black. The rock appears brecciated on outcrop surface. Map unit 5.

Petrographic Description. Fine to medium grained, massive, inequigranular-porphyritic-hyal, hypidiomorphic. Minor interstitial anhedral biotite is present. Pyroxene is anhedral to subhedral, elongate, with colourless cores and green rims. Pyroxene is an aegirine-augite. Nepheline is anhedral, interlocking with pyroxene in matrix. Phenocrysts are euhedral fresh nepheline.

Reference No. 368
Sample No. BL4-17

Biotite Ijolite

Field Description. Fine to coarse grained, massive. Weathered and fresh surfaces are black. Pyroxene cleavage faces are up to 1 cm across. Map unit 5.

Petrographic Description. Medium grained, inequigranular-seriate, hypidiomorphic. Biotite has a porphyroblastic relationship with respect to pyroxene and nepheline. Biotite forms anhedral ragged crystals with poikilitic pyroxene and nepheline. Magnetite forms anhedral disseminated grains. Pyroxene forms anhedral to subhedral elongated grains, with colourless cores and weak pale green rims of sodic pyroxene on larger grains. Nepheline is anhedral to subhedral in outline, and interlocks with pyroxene grains.

Reference No. 369
Sample No. BL4-15

Albite-bearing Ijolite

Field Description. Coarse grained, massive, equigranular. Weathered and fresh surfaces are mottled pink and black. Grain size approaches 1 cm. Map unit 5.

Petrographic Description. Fine to medium grained, equigranular, massive, hypidiomorphic. Spinel forms wedge-shaped crystals. Pyroxene is a dark green aegirine-augite, which forms elongate crystals of anhedral to subhedral outline. Nepheline forms anhedral grains with local alteration to cancrinite along cleavages. Albite forms anhedral irregular grains with relict albite twinning. Plagioclase displays turbid saussuritization.

Reference No. 370
Sample No. SB7-44

Ijolite

Field Description. Fine to coarse grained, inequigranular-seriate. Weathered and fresh surfaces are mottled black and pink. Rock sample is homogeneous but nepheline-rich; coarse-grained segregations are present in outcrop. These urtite segregations are generally less than 0.3 m in maximum width. Hint of banding on outcrop surface. Map unit 5.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic. Pyroxene is aegirine-augite, anhedral to subhedral in form, light green in colour; larger grains are very weakly zoned. Nepheline forms anhedral to subhedral grains with traces of turbid alteration along cleavage planes. Magnetite forms anhedral disseminated grains. Biotite forms reddish brown, anhedral, ragged grains with poikilitic pyroxene and magnetite.

Reference No. 1568

Sample No. SB7-103

Sovite

Field Description. Outcrop consists of mixed sovite and silicocarbonatite. Sample was taken from sovite. Sovite weathers rusty brown and is pink on fresh surface. Rock is fine to medium grained and inequigranular. Convolute banding is well developed and the rock contains xenoliths of silicocarbonatite. Banding due to variations in silica mineral content has a general east trend and bands are 1-2 mm to 1 cm wide. Sample is of purest possible sovite. Map unit 7.

Petrographic Description. Fine grained, inequigranular-seriate, allotriomorphic to hypidiomorphic, with straight to curved grain boundaries. Trace of dark reddish brown pyrochlore are present. Carbonate forms an interlocking mosaic of anhedral grains which locally display euhedral crystal faces projecting into interstitial quartz. Quartz forms anhedral interstitial grains occupying space between euhedral crystal faces of carbonate. Trace to minor anhedral biotite forms tiny grains and radiating sheafs undergoing alteration to chlorite. Trace to minor amounts of chlorite are present.

Reference No. 1589

Sample No. BL4-2B2

Pyrochlore-biotite-bearing, magnetite sovite

Field Description. Fine grained. Weathered surfaces are rusty brown and slightly magnetic; fresh surfaces are grey to dark grey. The outcrop is banded with a trend of 020°, dipping 65° northwest. Sample was taken from a prospect pit. The sample was taken from a sovite dike cutting mafic breccia. Map unit 7.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic, with curved grain boundaries. Carbonate forms an interlocking mosaic of anhedral grains. Pyrochlore occurs as reddish brown, euhedral to subhedral grains. Traces of fibrous amphibole are present. Biotite forms relatively small, anhedral to subhedral disseminated grains. Magnetite occurs as anhedral to subhedral disseminated grains. Magnetite is locally concentrated into bands.

CARBONATITE - ALKALIC ROCK COMPLEXES: SEABROOK LAKE

TABLE A-2. MAJOR ELEMENT ANALYSES (WEIGHT PERCENT) OF WHOLE-ROCK SAMPLES FROM THE SEABROOK LAKE CARBONATITE COMPLEX.

Ref. No.	Unit 5 - Ijolite						
	352	353	354	355	356	357	358
SiO ₂	40.7	40.1	42.3	43.1	41.1	42.2	44.3
Al ₂ O ₃	12.1	13.0	15.3	13.4	18.2	14.8	16.3
Fe ₂ O ₃	4.37	4.01	3.88	2.54	3.00	3.41	3.97
FeO	6.60	7.73	5.96	5.39	5.07	5.31	5.23
MgO	7.71	5.96	5.05	5.39	3.34	4.19	2.82
CaO	13.6	11.8	11.3	14.0	8.65	11.9	10.2
Na ₂ O	4.72	5.25	7.39	6.44	9.28	7.74	8.18
K ₂ O	3.15	3.65	3.38	3.04	4.11	3.40	3.51
TiO ₂	3.77	3.95	3.12	3.72	2.44	3.16	2.69
P ₂ O ₅	1.10	1.00	0.14	1.20	0.80	1.30	0.83
S	0.06	0.11	0.03	0.01	0.02	0.09	0.05
MnO	0.20	0.23	0.21	0.19	0.17	0.21	0.24
CO ₂	0.32	0.54	0.48	0.34	1.46	0.58	0.32
H ₂ O+	0.21	0.92	0.14	0.07	0.95	0.31	0.47
H ₂ O-	0.44	0.38	0.36	0.39	0.44	0.45	0.48
Total	99.05	98.63	99.04	99.22	99.03	99.05	99.59

Ref. No.	Unit 5 - Ijolite						
	359	360	361	362	363	370	364
SiO ₂	42.3	44.7	41.0	40.3	40.4	39.1	39.3
Al ₂ O ₃	18.2	15.6	15.3	14.6	15.2	14.8	20.4
Fe ₂ O ₃	2.50	3.80	3.83	4.81	3.71	2.80	1.97
FeO	4.43	5.23	5.39	6.20	6.20	6.12	4.67
MgO	3.99	3.23	5.41	5.21	4.80	6.24	2.91
CaO	10.4	9.42	12.7	12.2	12.0	14.0	9.17
Na ₂ O	8.89	8.13	6.89	7.00	7.25	5.80	9.80
K ₂ O	4.07	4.06	3.45	3.20	3.34	3.17	4.39
TiO ₂	2.78	2.55	3.01	3.54	3.45	3.70	2.43
P ₂ O ₅	1.10	0.87	1.20	1.10	1.30	1.24	1.52
S	0.05	0.12	0.07	0.03	0.13	0.02	0.11
MnO	0.16	0.21	0.18	0.22	0.20	0.16	0.14
CO ₂	0.42	1.42	0.50	0.46	0.48	0.78	0.90
H ₂ O+	0.21	0.11	-	0.21	0.20	0.72	0.74
H ₂ O-	0.33	0.45	0.43	0.46	0.43	0.39	0.35
Total	99.83	99.90	99.36	99.54	99.09	99.04	98.80

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
352	SB7-2	359	SB7-22
353	SB7-3	360	SB7-27 (malignite)
354	SB7-8	361	SB7-29
355	SB7-9	362	SB7-30
356	SB7-13	363	SB7-31
357	SB7-15	370	SB7-44
358	SB7-17	364	SB7-48

TABLE A-2. CONTINUED.

Ref. No.	Unit 5 - Ijolite					Unit 7 - Sovite	
	365	366	367	369	368	1569	1568
SiO ₂	40.1	40.4	41.0	47.4	44.3	0.71	2.22
Al ₂ O ₃	14.9	13.8	15.4	16.3	13.7	0.30	0.84
Fe ₂ O ₃	6.81	4.96	3.48	5.46	3.40	4.31	0.00
FeO	3.86	5.80	6.68	6.16	6.29	4.33	3.56
MgO	5.83	5.07	3.26	1.75	4.44	1.73	4.43
CaO	12.2	13.7	11.7	7.31	12.9	48.1	42.8
Na ₂ O	6.29	6.00	8.77	6.80	5.76	0.10	0.71
K ₂ O	3.56	3.31	2.86	4.49	3.32	0.14	0.27
TiO ₂	3.45	3.54	2.04	3.40	3.24	0.07	0.09
P ₂ O ₅	1.10	1.16	2.60	0.38	0.94	0.25	0.01
S	0.08	0.16	0.48	0.17	0.09	0.33	0.08
MnO	0.19	0.23	0.12	0.25	0.20	1.05	0.54
CO ₂	0.78	0.54	0.29	0.58	0.46	39.2	40.3
H ₂ O+	0.41	0.42	0.64	1.17	0.43	0.15	0.22
H ₂ O-	0.34	0.30	0.34	0.47	0.08	0.07	0.04
Total	99.90	99.39	99.66	102.00	99.60	100.80	96.10

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
365	SB7-49	368	BL4-17
366	SB7-53 (melteigite)	1569	BL4-2B2
367	SB7-60A	1568	SB7-103
369	BL4-15		

CARBONATITE - ALKALIC ROCK COMPLEXES: SEABROOK LAKE

TABLE A-3. TRACE ELEMENT ANALYSES (PPM) OF WHOLE-ROCK SAMPLES FROM THE SEABROOK LAKE CARBONATITE COMPLEX.

Ref. No.	Unit 5 - Ijolite						
	352	353	354	355	356	357	358
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	1400	1200	270	290	480	360	320
Be	4	5	5	4	6	7	7
Bi							
Co	40	35	25	25	15	20	20
Cr	200	145	75	95	20	55	15
Cu	60	65	30	20	15	40	35
Ga	10	15	10	10	15	15	15
Hg							
Li	4	4	3	4	5	6	5
Mn							
Mo	<1	<1	<1	<1	<1	<1	<1
Nb	100	150	100	150	150	100	150
Ni	155	65	45	40	30	50	10
Pb	20	<10	<10	<10	10	20	<10
Rb	90	120	70	70	70	70	90
Sb							
Sc	15	10	10	10	5	9	<5
Sn	<3	3	<3	<3	4	<3	3
Sr	1000	1000	700	900	1000	1000	800
Ti							
V	300	300	250	150	150	150	150
Y	45	40	35	50	45	50	50
Zn	110	135	105	85	100	135	120
Zr	200	250	250	300	250	250	600
La	200	100	<100	<100	<100	150	<100
Nd	<100	<100	<100	<100	<100	<100	<100
Ce	859	848	511	724	475	709	580
Eu	<100	<100	<100	<100	<100	<100	<100
Yb	2	2	2	2	1	2	3

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
352	SB7-2	356	SB7-13
353	SB7-3	357	SB7-15
354	SB7-8	358	SB7-17
355	SB7-9		

TABLE A-3. CONTINUED.

Ref. No.	Unit 5 - Ijolite						
	359	360	361	362	363	370	364
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	280	810	170	190	420	620	300
Be	5	9	5	5	5	3	5
Bi							
Co	20	20	25	25	30	30	15
Cr	<5	25	25	60	30	40	10
Cu	20	25	55	15	65	30	40
Ga	15	15	15	15	15	15	15
Hg							
Li	4	5	<3	3	<3	4	3
Mn							
Mo	<1	<1	<1	<1	<1	<1	<1
Nb	150	100	100	80	100	150	150
Ni	30	15	40	35	25	30	25
Pb	<10	15	25	<10	<10	25	25
Rb	70	100	50	60	80	50	80
Sb							
Sc	6	5	10	10	10	10	7
Sn	4	<3	<3	3	<3	<3	<3
Sr	1000	1000	1000	900	1000	3000	1000
Ti							
V	150	150	250	200	250	250	150
Y	50	45	45	40	45	45	45
Zn	80	115	100	115	100	75	70
Zr	250	300	250	200	200	200	200
La	150	<100	100	<100	100	200	150
Nd	<100	<100	<100	<100	<100	<100	<100
Ce	420	430	650	770	750	720	540
Eu	<100	<100	<100	<100	<100	<100	<100
Yb	2	2	2	2	2	1	1

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
359	SB7-22	363	SB7-31
360	SB7-27 (malignite)	370	SB7-44
361	SB7-29	364	SB7-48
362	SB7-30		

CARBONATITE - ALKALIC ROCK COMPLEXES: SEABROOK LAKE

TABLE A-3. CONTINUED.

Ref. No.	Unit 5 - Ijolite					Unit 7 - Sovite	
	365	366	367	369	368	1569	1568
Ag	<1	<1	<1	<1	<1	<1	<2
Au							
As						<1	
Ba	410	470	220	1000	450	1500	500
Be	5	4	10	5	3	<3	1
Bi							
Co	30	30	20	20	40	20	8
Cr	145	10	10	<10	100	15	6
Cu	35	75	30	40	40	10	7
Ga	15	15	15	40	25	<5	2
Hg							
Li	4	4	4	<20	<20	<20	<3
Mn							
Mo	<1	<1	<1	<10	<10	<10	<10
Nb	90	150	200	-	-	700	680
Ni	65	10	7	30	110	10	<5
Pb	<10	<10	30	<10	<10	230	19
Rb	70	70	40	-	-	<10	10
Sb						<4	
Sc	15	8	<5	<20	<20	20	3
Sn	<3	<3	8	<10	<10	10	5
Sr	1000	900	700	700	700	5000	2140
Ti							
V	250	250	200	150	200	40	50
Y	40	45	40	20	20	600	50
Zn	110	105	125	260	110	420	66
Zr	200	250	800	450	250	80	11
La	100	100	<100	-	-	700	345
Nd	<100	<100	<100	-	-	1000	310
Ce	810	650	420	-	-	800	1090
Eu	<100	<100	<100	-	-	-	-
Yb	1	2	2	-	-	-	-

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
365	SB7-49	368	BL4-17
366	SB7-53 (melteigite)	1569	BL4-2B2
367	SB7-60A	1568	SB7-103
369	BL4-15		

TABLE A-4. NORMATIVE MINERALS (CIPW NORM) FOR WHOLE-ROCK SAMPLES FROM THE SEABROOK LAKE CARBONATITE COMPLEX.

Unit 5 - Ijolite							
Ref. No.	352	353	354	355	356	357	358
S.G.	3.14	3.09	3.03	3.07	2.87	3.02	2.97
AP	2.602	2.398	0.331	2.828	1.930	3.088	1.959
PO	0.168	0.312	0.084	0.028	0.057	0.253	0.139
IL	7.302	7.755	6.044	7.179	4.819	6.145	5.197
OR	0.0	0.0	0.0	0.0	0.0	0.0	13.464
AB	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AN	2.570	1.157	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	2.391	2.239	7.148	7.492	4.414
MT	6.462	6.010	4.540	2.620	0.941	1.308	3.644
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.264	5.480	8.031	1.775	5.792	7.910
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	33.167	27.823	20.664	28.639	6.905	16.429	15.410
FO	2.947	1.713	2.275	0.253	3.817	2.149	0.0
FA	0.407	0.551	0.702	0.054	2.529	0.868	0.0
NE	22.063	24.874	33.075	28.614	39.831	31.715	35.426
LC	14.899	17.499	15.988	14.326	19.820	16.145	6.004
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	3.628	7.084	5.048	4.833	3.619	5.251	6.432
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	3.784	2.562	3.378	0.355	6.810	3.365	0.0

S.G. - Specific Gravity; AP - Apatite; PO - Pyrrhotite; IL - Ilmenite; OR - Orthoclase;
 AB - Albite; AN - Anorthite; C - Corundum; AC - Acmite; MT - Magnetite;
 HM - Hematite; WO - Wollastonite; EN - Enstatite; FS - Ferrosillite; Q - Quartz;
 DI - Diopside; FO - Forsterite; FA - Fayalite; NE - Nepheline; LC - Leucite;
 KP - Kaliophillite; HE - Hedenbergite; CC - Calcite; RU - Rutile; NS - Na_2SiO_3 ;
 KS - Kalsilite; CR - Chromite; LN - Larnite.

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
352	SB7-2	356	SB7-13
353	SB7-3	357	SB7-15
354	SB7-8	358	SB7-17
355	SB7-9		

CARBONATITE - ALKALIC ROCK COMPLEXES: SEABROOK LAKE

TABLE A-4. CONTINUED.

Unit 5 - Ijolite							
Ref. No.	359	360	361	362	363	370	364
S.G.	2.95	2.94	3.05	3.09	3.03	3.04	2.87
AP	2.584	2.062	2.829	2.593	3.080	2.961	3.644
PO	0.139	0.336	0.195	0.084	0.364	0.056	0.312
IL	5.347	4.949	5.810	6.833	6.692	7.234	4.770
OR	0.0	0.343	0.0	0.0	0.0	0.0	0.0
AB	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AN	0.0	0.0	0.636	0.0	0.0	5.128	0.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	3.819	10.054	0.0	1.754	1.590	0.0	2.227
MT	1.757	0.592	5.644	6.209	4.697	4.179	1.836
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	4.770	3.538	5.677	5.275	5.022	2.970	3.617
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	12.138	17.729	22.543	21.219	19.844	17.559	2.341
FO	3.108	0.0	2.271	2.346	2.108	5.506	4.488
FA	0.913	0.0	0.336	0.467	0.565	1.183	2.292
NE	38.915	31.894	32.094	31.527	32.958	27.365	45.053
LC	19.116	18.972	16.261	15.083	15.820	15.134	21.043
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	2.820	9.532	2.640	3.343	4.205	2.986	0.946
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	4.576	0.0	3.064	3.267	3.057	7.739	7.431

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
359	SB7-22	363	SB7-31
360	SB7-27 (malignite)	370	SB7-44
361	SB7-29	364	SB7-48
362	SB7-30		

TABLE A-4. CONTINUED.

Ref. No.	Unit 5 - Ijollite					Unit 7 Sovite
	365	366	367	369	368	1569
S.G.	3.09	2.98	3.00	2.90	3.06	2.86
AP	2.595	2.744	1.153	0.884	2.213	0.577
PO	0.223	0.447	0.341	0.467	0.250	0.901
IL	6.664	6.857	5.113	6.474	6.245	0.132
OR	0.0	0.0	0.0	26.332	17.045	0.824
AB	0.0	0.0	0.0	14.634	0.0	0.760
AN	1.934	0.960	0.0	0.833	1.741	0.0
C	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	9.964	0.0	0.0	0.073
MT	2.526	7.334	0.231	7.937	5.003	6.185
HM	5.183	0.0	0.0	0.0	0.0	0.0
WO	4.753	9.983	6.816	7.898	7.770	0.0
EN	0.0	0.0	0.0	0.0	0.0	1.273
FS	0.0	0.0	0.0	0.0	0.0	1.445
Q	0.0	0.0	0.0	0.0	0.0	0.0
DI	25.234	25.264	5.000	9.425	24.204	-4.498
FO	2.149	0.816	4.266	0.0	0.0	3.575
FA	0.0	0.034	4.570	0.0	0.0	4.473
NE	29.318	28.046	35.491	23.321	26.792	0.0
LC	16.791	15.656	13.733	0.0	2.261	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0
HE	0.0	0.831	4.238	1.795	6.476	-4.453
CC	0.0	0.0	0.0	0.0	0.0	88.732
RU	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0
LN	2.630	1.027	9.084	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
365	SB7-49	369	BL4-15
366	SB7-53 (melteigite)	368	BL4-17
367	SB7-60A	1569	BL4-2B2

CARBONATITE - ALKALIC ROCK COMPLEXES: SEABROOK LAKE

TABLE A-5. NORMATIVE MINERALS (ALKALIC ROCKS) FOR WHOLE-ROCK SAMPLES FROM THE SEABROOK LAKE CARBONATITE COMPLEX.

Ref. No.	Unit 5 - Ijolite						
	352	353	354	355	356	357	358
QZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OR	6.15	9.06	0.01	0.93	1.47	1.73	2.18
AB	2.27	4.68	3.47	3.85	6.25	5.29	11.84
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	26.14	26.23	41.88	35.74	47.86	38.53	38.94
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	1.18	1.76	6.14	4.14	2.60
TH	0.66	1.20	0.35	0.13	0.22	0.97	0.53
GEH	3.77	3.42	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	15.63	11.63	17.20	19.39	8.32	14.96	14.09
D.EN	9.01	5.98	8.79	10.57	3.85	7.41	5.81
D.FS	5.89	5.35	7.96	8.11	4.39	7.24	8.36
FO	7.08	6.17	2.61	1.96	3.11	2.09	0.83
FA	5.11	6.09	2.61	1.66	3.92	2.25	1.31
ANDR	0.	0.0	0.0	0.0	0.0	0.0	0.0
HM	4.38	2.33	3.48	1.93	0.68	1.98	3.08
MT	0.0	2.45	0.0	0.0	0.28	0.0	0.0
SPH	9.25	9.69	7.65	9.13	5.99	7.75	6.60
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AP	2.60	2.37	0.33	2.84	1.89	3.08	1.96
CC	0.73	1.23	1.09	0.77	3.32	1.32	0.73
MGS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H ₂ O	0.65	1.30	0.50	0.46	1.39	0.76	0.95
SUM	99.31	99.15	99.13	99.25	99.10	99.49	99.81

QZ - Quartz; CO - Corundum; OR - Orthoclase; AB - Albite; LC - Leucite;
 KAL - Kalsilite; NEPH - Nepheline; CAR - Carnegelite; NS - Na₂SiO₃; AC - Acmite;
 TH - Thenardite; GEH - Gehlenite; AKM - Akermanite; FE-AK - Fe-Akermanite;
 D.WO - Wollastonite; D.EN - Enstatite; D.FS - Ferrosilite; FO - Forsterite;
 FA - Fayalite; ANDR - Andradite; HM - Hematite; MT - Magnetite; SPH - Sphene;
 PERV - Perovskite; RU - Rutile; AP - Apatite; CC - Calcite; MGS - Magnesite;
 FL - Fluorite; ZR - Zircon; BAD - Baddeleyite.

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of Lebas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
352	SB7-2	356	SB7-13
353	SB7-3	357	SB7-15
354	SB7-8	358	SB7-17
355	SB7-9		

TABLE A-5. CONTINUED.

Ref. No.	Unit 5 - Ijolite						
	359	360	361	362	363	370	364
QZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OR	0.55	8.09	2.12	0.0	1.72	2.50	0.49
AB	4.53	12.72	3.90	2.50	5.67	2.38	6.56
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	49.31	33.34	38.32	39.68	37.81	34.06	53.41
CAR	0.0	0.0	0.0	0.72	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	2.03	5.50	0.0	0.71	0.0	0.0	0.0
TH	0.53	1.33	0.75	0.31	1.28	0.22	1.20
GEH	0.0	0.0	2.07	0.0	1.56	5.34	1.04
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	13.37	9.67	15.56	15.89	13.69	13.63	8.05
D.EN	7.01	4.29	8.50	8.10	6.75	7.51	3.60
D.FS	5.97	5.35	6.48	7.39	6.67	5.60	4.41
FO	2.03	2.61	3.45	3.38	3.61	5.58	2.53
FA	1.91	3.59	2.90	3.41	3.94	4.59	3.42
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	1.80	1.90	3.84	4.57	3.72	2.81	1.97
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SPH	6.82	6.26	7.38	8.68	8.46	9.08	5.96
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AP	2.60	2.06	2.84	2.60	3.08	2.94	3.60
CC	0.95	3.23	1.14	1.05	1.09	1.77	2.04
MGS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H ₂ O	0.54	0.56	0.43	0.67	0.63	1.11	1.09
SUM	99.95	100.49	99.68	99.65	99.66	99.11	99.37

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of Lebas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
359	SB7-22	363	SB7-31
360	SB7-27 (malignite)	370	SB7-44
361	SB7-29	364	SB7-48
362	SB7-30		

CARBONATITE - ALKALIC ROCK COMPLEXES: SEABROOK LAKE

TABLE A-5. CONTINUED.

Ref. No.	Unit 5 - Ijolite					Unit 7 - Sovite	
	365	366	367	369	368	1569	1568
QZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.15	0.0
OR	5.56	5.55	0.0	16.04	6.63	0.0	0.0
AB	6.23	4.63	4.61	25.97	10.56	0.0	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.47	0.34
NEPH	32.46	29.39	35.46	21.36	27.25	0.0	2.09
CAR	0.0	0.0	5.91	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.44
AC	0.0	0.0	5.30	0.0	0.0	0.0	0.0
TH	0.89	1.77	1.33	0.75	0.40	0.23	0.35
GEH	3.59	4.35	0.0	2.28	2.46	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.24	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	3.22	2.37
D.WO	12.14	14.93	13.74	5.69	16.12	-2.66	-1.81
D.EN	7.53	7.72	5.38	2.23	7.63	-0.18	0.0
D.FS	3.87	6.80	8.53	3.53	8.27	-2.80	-2.06
FO	4.86	3.40	1.89	1.48	2.37	0.35	0.0
FA	2.76	3.31	3.31	2.57	2.83	5.98	6.63
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	6.82	4.97	1.65	0.0	3.41	0.0	0.0
MT	0.0	0.0	0.0	8.66	0.0	6.26	0.0
SPH	8.46	8.68	6.38	8.34	7.95	0.0	0.0
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.07	0.09
AP	2.60	2.75	1.14	0.90	2.23	0.59	0.02
CC	1.77	1.23	4.64	1.32	1.05	85.18	76.30
MGS	0.0	0.0	0.0	0.0	0.0	3.27	9.23
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H ₂ O	0.75	0.72	0.98	1.64	0.51	0.22	0.26
SUM	100.28	100.20	100.24	102.75	99.64	100.59	94.25

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of Lebas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
365	SB7-49	368	BL4-17
366	SB7-53 (melteigite)	1569	BL4-2B2
367	SB7-60A	1568	SB7-103
369	BL4-15		

TABLE A-6. AVERAGE CHEMICAL COMPOSITIONS (WEIGHT PERCENT AND PPM) OF LITHOLOGIC UNITS FOR THE SEABROOK LAKE CARBONATITE COMPLEX.

	Ijolite* Unit 5 (N = 19)		Sovite Unit 7 (N = 2)	
	Mean	Std. Deviation	Mean	Std. Deviation
SiO ₂	41.79	2.15	1.47	1.07
Al ₂ O ₃	15.33	1.97	0.57	0.38
Fe ₂ O ₃	3.83	1.14	2.15	3.05
FeO	5.70	0.90	3.94	0.54
MgO	4.56	1.45	3.08	1.91
CaO	11.53	1.90	45.45	3.75
Na ₂ O	7.18	1.41	0.41	0.43
K ₂ O	3.55	0.46	0.21	0.09
TiO ₂	3.16	0.54	0.08	0.01
P ₂ O ₅	1.10	0.49	0.13	0.17
MnO	0.20	0.03	0.79	0.36
CO ₂	0.61	0.33	39.75	0.78
S	0.10	0.10	0.21	0.18
H ₂ O+	0.44	0.33	0.19	0.05
H ₂ O-	0.38	0.09	0.05	0.02
LOI	0.00	0.00	20.05	28.35
TOTAL	99.46	0.72	98.45	3.32
Ag	<1.00	0.00	<1.50	0.71
As			<1.00	0.00
Ba	508.42	349.46	1000.00	707.11
Co	25.53	7.43	14.00	8.49
Cr	55.00	58.05	10.50	6.36
Cu	38.68	17.78	8.50	2.12
Li	0.84	7.71	<11.50	12.02
Ni	43.00	36.30	2.50	10.61
Pb	3.16	16.35	124.50	149.20
Sb			<4.00	0.00
Zn	113.42	39.86	243.00	250.32
Be	5.37	1.80	<1.00	2.83
Mo	<1.95	2.84	<10.00	0.00
Sc	6.84	8.79	11.50	12.02
Sr	1015.79	495.83	3570.00	2022.33
V	205.26	55.01	45.00	7.07
Y	41.84	8.69	325.00	388.91
Ga	16.05	6.58	<1.50	4.95
Nb	127.65	33.08	690.00	14.14
Rb	73.53	19.35	0.00	14.14
Zr	297.37	156.77	45.50	48.79
Sn	<1.47	4.60	7.50	3.54
Eu	<100.00	0.00		
Yb	1.82	0.53		
Ce	639.18	151.22	945.00	205.06
La	38.24	123.15	522.50	251.02
Nd	<100.00	0.00	655.00	487.90

*Includes one sample of malignite and one of melteigite.

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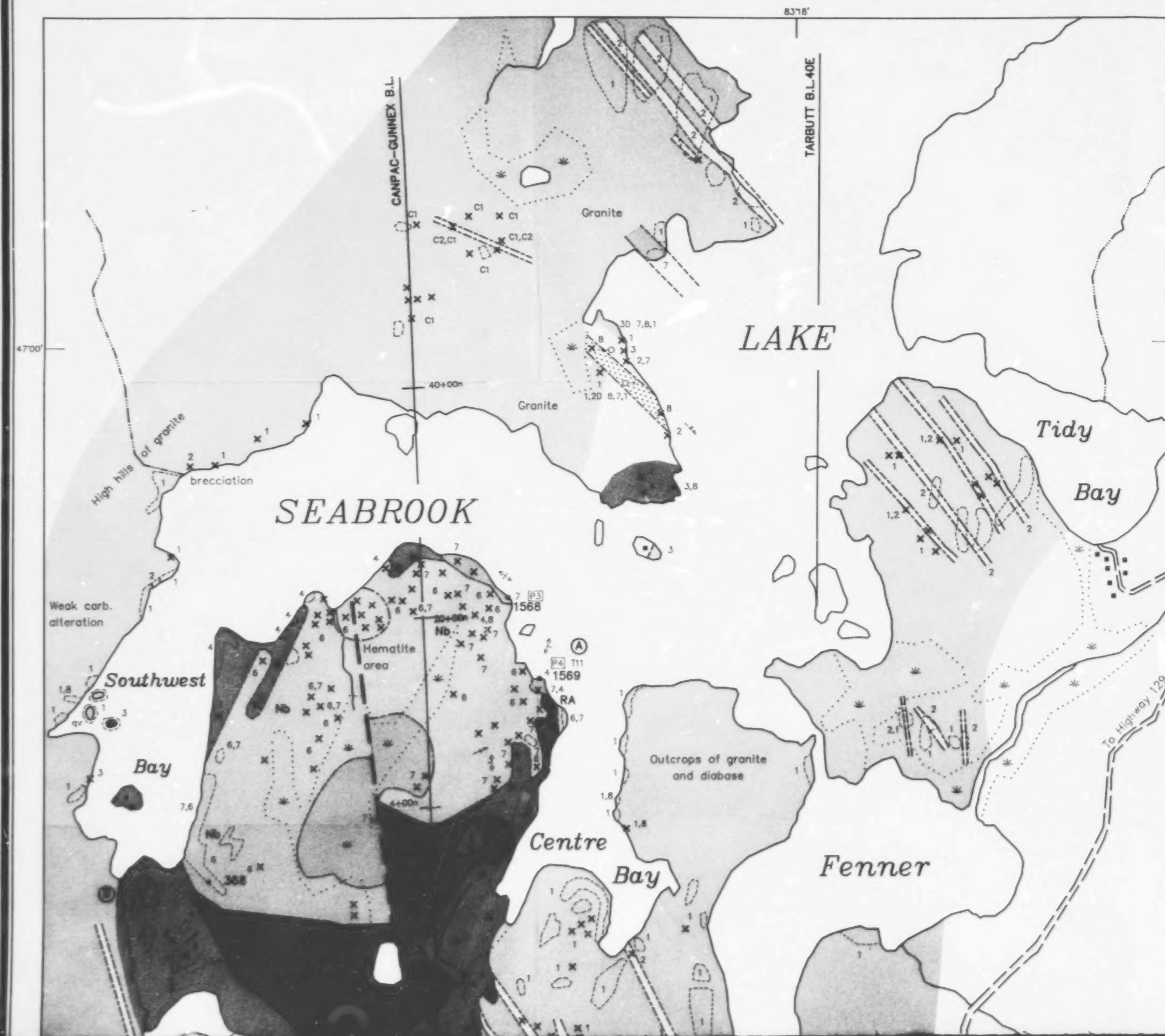


Chart A — Seabrook Lake Carbonatite Complex

Figure 3. Geology of the Seabrook Lake Carbonatite Complex. Geology modified by R.P. Sage from Map 2005 (Parsons 1961). Additional information from assessment work files and company files.

LEGEND

CENOZOIC¹ **QUATERNARY** **RECENT**

Stream, lake, and swamp deposits

PLEISTOCENE

Glacial deposits

UNCONFORMITY

LATE PRECAMBRIAN (PROTEROZOIC)² **SEABROOK LAKE CARBONATITE COMPLEX** **DIKE ROCKS**



8 Mafic alkaline dike rocks³, biotite-calcite rocks.

INTRUSIVE CONTACT

CARBONATITE ROCKS



7 Sovite, sovite dikes, hematite sovite.



6 Silicocarbonatite, locally brecciated, sovite.

INTRUSIVE CONTACT

IJOLITIC ROCKS



5 Ijolite, biotite ijolite, malignite.

INTRUSIVE CONTACT

FENITES



4 Fenitized granite breccia.



3 Fenitized granite.

INTRUSIVE CONTACT

MIDDLE PRECAMBRIAN (PROTEROZOIC)² **DIABASE DIKES**



2 Diabase.

INTRUSIVE CONTACT

EARLY PRECAMBRIAN (ARCHEAN)² **GRANITIC ROCKS**



1 Granodiorite to quartz monzonite.

NOTES

1. Unconsolidated deposits.
2. Bedrock geology.
3. Cutting unit 4.

ABBREVIATIONS

Nb Niobium
qv Quartz vein

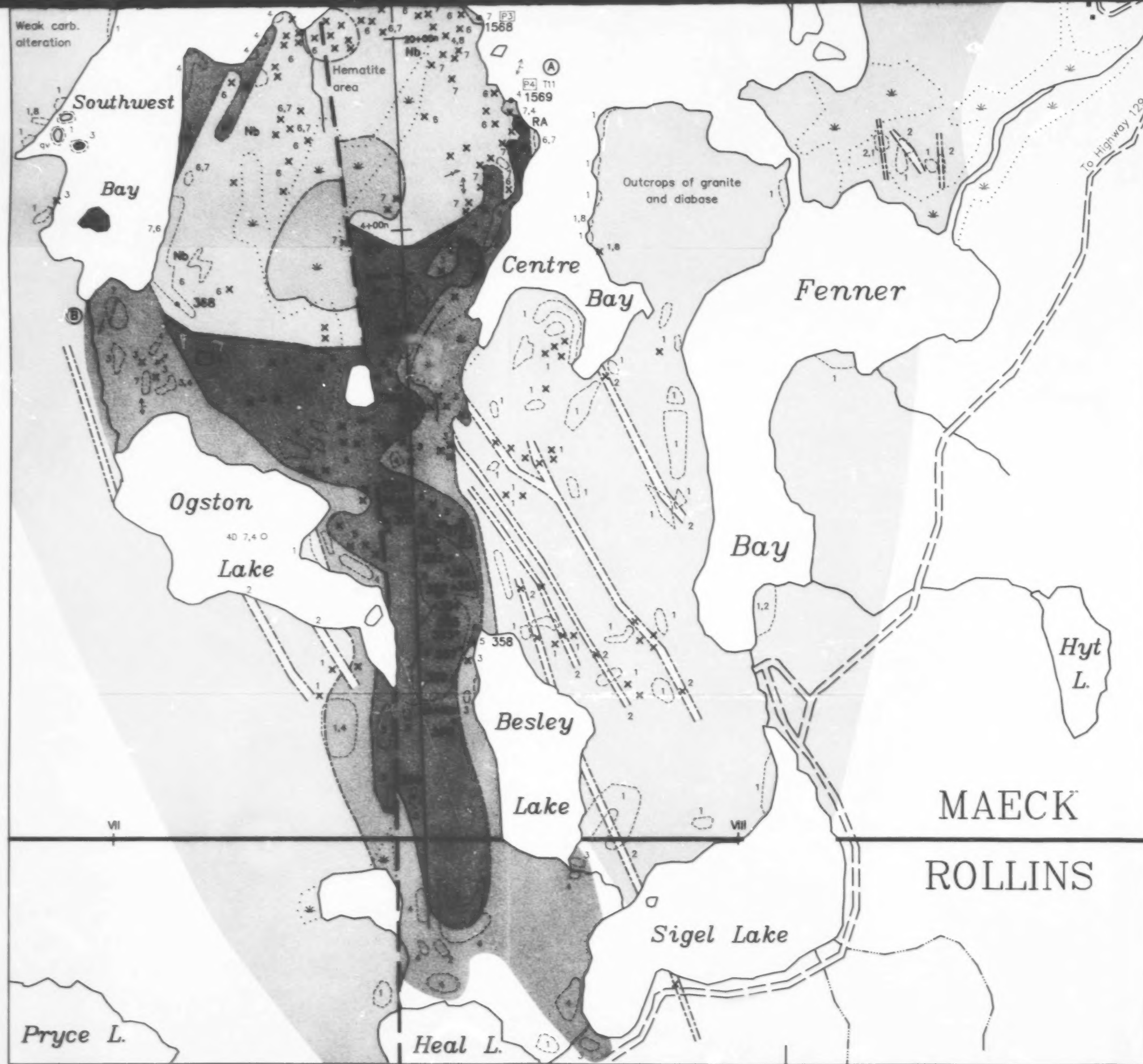
SYMBOLS



Small bedrock outcrop.



Area of bedrock outcrop.



- 3 Fertilized granite.
INTRUSIVE CONTACT
- MIDDLE PRECAMBRIAN (PROTEROZOIC)²
DIABASE DIKES
2 Diabase.
INTRUSIVE CONTACT
- EARLY PRECAMBRIAN (ARCHEAN)²
GRANITIC ROCKS
1 Granodiorite to quartz monzonite.

- NOTES
1. Unconsolidated deposits.
 2. Bedrock geology.
 3. Cutting unit 4.

ABBREVIATIONS

Nb Niobium
qv Quartz vein

- SYMBOLS
-  Small bedrock outcrop.
 -  Area of bedrock outcrop.
 -  Lithologic data from diamond drilling.
 -  Lithologic data compiled from assessment files.
 -  Location of sample for whole rock analysis (see report appendix).
 -  Location of photo (see report).
 -  Mineral occurrence described by Parsons 1961 (see report).
 -  Foliation; (inclined, vertical).
 -  Banding; (inclined, vertical).
 -  Fault (interpreted).
 -  Geological boundary (position interpreted; deduced from geophysics).
 -  Diamond drill hole (vertical, inclined).
 -  Stream.
 -  Swamp.
 -  Township boundary (approximate location).
 -  Building.

Scale 1:10 000

